Appendix H

Traffic and Transportation

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Traffic and Transportation

This section evaluates the radiological and non-radiological impacts of onsite shipments of LLW, MLLW (including melters), TRU waste, and ILAW to treatment and disposal facilities, offsite shipments of MLLW from Hanford to offsite treatment facilities and back, and the shipment of construction and capping materials. This appendix also presents the impacts of shipments of LLW and MLLW from offsite generators to Hanford treatment and disposal facilities and shipments of TRU waste from Hanford to the Waste Isolation Pilot Plant (WIPP) for disposal. The impacts of shipments of LLW, MLLW, and TRU from offsite generators to Hanford and from Hanford to WIPP are presented for the States of Washington and Oregon. The impacts of shipments of LLW, MLLW, and TRU from offsite generators to Hanford were calculated for the States of Washington and Oregon using methods and data that are consistent with the *Waste Management Programmatic Environmental Impact Statement* (WM-PEIS, DOE 1997a). Estimated impacts of transporting TRU waste to WIPP are scaled from information presented in the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (DOE 1997b).

Estimates in the environmental impact statement (EIS) of radiological and non-radiological impacts of transporting various types of waste are presented in the following sections. This analysis addresses radiological hazards of waste transported under routine and accident conditions, and chemical hazards of waste transportation accidents, as well as physical hazards (that is, fatalities) projected to occur from traffic accidents involving waste shipments. Health effects from routine vehicular emissions are also quantified. The physical (or non-radiological) hazards and the impacts of routine vehicular emissions are independent of the cargo being transported. Total integrated radiological and non-radiological impacts are calculated. Note that all of the methods used in this appendix to calculate transportation impacts are commonly used in U.S. Department of Energy (DOE) environmental documents. Potential impacts of sabotage or acts of terrorism are also addressed. Finally, the transportation impacts associated with the *Final Waste Management Programmatic Environmental Impact Statement* (WM PEIS, DOE 1997a) are compared to the transportation impacts in this EIS.

H.1 Description of Methods

The methods used in this EIS to calculate the impacts of transporting waste, construction, and capping materials are described in the following section. Section H.1.1 describes the RADTRAN 4 computer code that was used to calculate the radiological routine (or incident-free) doses and accident risks to the public and transport crews associated with the alternatives examined in the EIS. The method used to calculate physical (non-radiological) routine risks is described in Section H.1.2. The method used to calculate non-radiological accident risks is described in Section H.1.3; the method used to calculate the impacts of accidental releases of hazardous chemicals is described in Section H.1.4.

H.1.1 Radiological Impact Analysis Methodology

RADTRAN 4 (Neuhauser and Kanipe 1992) was used to estimate collective impacts to populations from routine transportation of radioactive material and collective population risks from accidents during transport. RADTRAN 4 is organized into eight models:

- material model
- transportation model
- population distribution models
- material models: isotopic compositions and properties
- accident severity and package behavior models
- meteorological dispersion model
- health-effects model
- economic model.

The code uses these models to calculate the potential population dose from normal (routine or incident-free) transportation and to calculate the risk to the population from user-defined accident scenarios.

Collective Population Doses from Routine (Incident-Free) Transport. The RADTRAN 4 incident-free models calculate doses to people on or near the transportation routes from low-level external radiation emitted from the loaded shipping containers. RADTRAN 4 calculates incident-free doses to the following population groups:

- **Persons along the route (referred to as *off-link population*)**. RADTRAN 4 calculates population doses to all persons living or working within 0.8 km (0.5 mi) on each side of a transportation route.

- **Persons sharing the route (*on-link population*)**. Collective doses are calculated for persons in vehicles sharing the transportation route, traveling in the same or in opposite directions.

- **Persons at stops**. RADTRAN 4 calculates collective doses to persons who may be exposed to a shipment while it is at a stop. For truck shipments to/from offsite locations, stops may be made for refueling, food, or rest. For onsite truck shipments, stop times are set to zero because of the short transport distances.

- **Crew members**. Incident-free doses to truck crew members are calculated.

The total collective population doses are the sum of the doses to the off-link population, on-link population, and persons at stops. Worker doses include the doses to truck crewmembers. Note the population doses resulting from onsite shipments are doses to Hanford Site workers that may be adjacent to or nearby a truck shipment of radioactive waste. Onsite shipments of radioactive waste would not expose a member of the public to any significant radioactive dose rate because Hanford Site access restrictions prevent the shipment from approaching locations where a member of the public could be. One exception would be shipments from the 300 Area or 400 Area to the 200 Areas treatment and disposal facilities. The highway from the 300 Area and 400 Area to the Wye Barricade is publicly accessible, and a member of the public (that is, a non-Hanford worker) could conceivably be on the highway at the time a waste shipment is being transported. However, many shipments of radioactive materials from the 300 Area and 400 Area to the 200 East and 200 West Areas are currently conducted during off-shift hours (for example, nights and weekends) and often require closure of the road between the 300 or 400 Area and the Wye Barricade. Consequently, except for this small potential dose to a non-Hanford worker member of the public, the doses to the public referred to in this appendix from onsite shipments are actually doses to Hanford workers who may be driving to/from or at their work locations as a waste shipment passes by. Doses to the public who are non-Hanford workers are associated with shipments of MLLW to offsite treatment facilities and back, offsite shipments of TRU waste to WIPP, and LLW, MLLW, and TRU shipments from offsite generators through Washington and Oregon to Hanford.

Incident-free doses calculated by RADTRAN 4 are generally based on extrapolating the dose rate emitted from the package as a function of distance from a point source. The public and worker doses are dependent upon parameters, such as population density, shipping distance, exposure distance, exposure duration, stop times, traffic density, and the Transportation Index (TI) of the package or packages. The TI is defined as the highest package dose rate (mrem per hour) that would be received by an individual located at a distance of 1 m (3.3 ft) from the external surface of the package. The values used for this and other parameters are presented in Table H.1.

RADTRAN 4 calculations are performed for each origin/destination pair. Onsite population densities and shipping distances are based on Hanford map distances and occupancies in buildings along the routes. The HIGHWAY computer code (Johnson et al. 1993) was used to determine the population densities and shipping distances in Washington and Oregon for shipments from offsite generators to Hanford.

The shipment origins, destinations, shipping distances, and number of shipments to be transported onsite in the Alternatives are presented later in this Appendix. The capacities of the various onsite shipment types are shown below:

- LLW Category 1 and non-conforming LLW – 7.5 m^3/shipment; Category 3 – 3.4 m^3/shipment

- CH MLLW – 3.4 m^3/shipment RH MLLW – 0.6 m^3/shipment; WTP melters – 175 m^3/shipment (one melter/shipment); elemental lead and mercury – 0.5 m^3/shipment

- TRU Drums – 3.4 m^3/shipment; TRU boxes – 5.7 m^3/shipment

- ILAW – 1 ILAW canister/shipment – 2.6 m^3/shipment.

Radioactive Waste Shipping Regulations and Packaging

The two key federal government agencies responsible for ensuring the safety of transporting radioactive materials are the U.S. Department of Transportation (DOT) and U.S. Nuclear Regulatory Commission (NRC). DOT regulations for the safe transportation of radioactive materials are found in Title 49 of the Code of Federal Regulations (49 CFR). NRC regulations are found in 10 CFR 71. These regulations establish a comprehensive set of requirements that assure appropriate packaging (or shipping container) commensurate with the hazard presented by the shipment is used, vehicle (tractor-trailer, railcar) safety and reliability routes are selected to minimize risk where appropriate, drivers are appropriately trained and accredited, and shipments are manifested and placarded in accordance with the level of hazard.

The most important element of ensuring safety is the packaging or shipping containers used to transport the waste materials. Federal regulations, which DOE must comply with for offsite shipments, establish two types of packagings that will be used for offsite transport of waste materials; Type A and Type B. The levels of radioactivity and the specific radionuclides contained in the wastes determine whether a shipment can be transported in a Type A or Type B package. In general, low hazard (i.e., low radioactive content) shipments are transported in Type A packages and high hazard (high radioactive content) shipments must be transported in Type B containers. Type A packages would be used for most LLW and MLLW shipments. These waste types are characterized by relatively low radiation levels and radionuclide concentrations. Type A packages are required to withstand a series of tests referred to as normal conditions of transport without functional failure. Type A packaging tests include a water spray test, drop test, stacking test, and penetration test. Examples of Type A containers used for transporting LLW and MLLW include 210-L (55-gal.) steel drums, steel boxes, and various sizes of concrete and steel shielded cylindrical containers. Type B packages, on the other hand, are used for radioactive materials that have relatively high radionuclide concentrations and/or relatively high concentrations of transuranic radionuclides, such as plutonium and americium. TRU waste and ILAW canisters would be shipped in Type B packages. Type B packages must withstand a series of hypothetical accident conditions that are designed to simulate severe accidents (including impact, puncture, thermal, and water immersion environments) in addition to the normal conditions of transport. Examples of Type B packages include the massive spent nuclear fuel shipping casks and the TRUPACT container being used to transport TRU wastes to WIPP. Properly designed, manufactured, tested, and maintained packaging systems are the backbone of DOE's transportation safety program.

Table H.1. General RADTRAN 4 Parameters for Onsite Waste Shipments[a]

Parameter	Value
Transport Index (dose rate at 1 m from shipping container, mrem/hr)[b]	
LLW and MLLW	1
CH TRU Waste	3
RH TRU Waste	7
Leachate in 5000-gal tanker truck	0.08[c]
ILAW	14[d]
Number of Truck Crew	2
Average Vehicular Speed (km/hr)	
Rural	88
Suburban	40
Urban	24
Stop Time (hr/km)	NA (No stops for onsite shipments)
Number of People Exposed While Stopped	
Average Exposure Distance at Stops	
Number of People per Vehicle Sharing Route	2
Population Densities (persons/km^2)	Route-specific
One-Way Traffic Count (vehicles/hr)	
Rural	470
Suburban	780
Urban	2800

(a) Source of the parameter values is Neuhauser and Kanipe (1992), except where indicated otherwise.
(b) Source: WM PEIS (DOE 1997a).
(c) Based on preliminary shielding calculations performed using the MICROSHIELD™ Computer Code, Version 5.0 (Grove Engineering 1996).
(d) Based on regulatory maximum external dose rate of 10 mrem/hr at 2 m from the shipping container.

Population density information for onsite shipments was obtained from the Spent Nuclear Fuel Programmatic EIS (DOE 1995). For shipments from unspecified locations to the 200 West Area, it was assumed that the origin of the shipment is the 300 Area, the onsite waste generators farthest from the 200 West Area. These shipments were assumed to travel a one-way distance of 40 km (25 mi) through a region defined by three population densities: 1.6 km (1 mi) through a region defined by the 300 Area population density (660 persons/km^2 or 1700 persons/mi^2); 6.4 km (4 mi) through a region defined by the 200 West Area population density (120 persons/km^2 or 300 persons/mi^2); and 32 km (20 mi) through a region with the 600 Area population density (0.14 persons/km^2 or 0.35 persons/mi^2). This analysis is conservative because most of the onsite personnel will be in buildings located on one side of the road or the other, although the code assumes a uniform population density on both sides of the road. Also, many of the shipments will come from the 200 East and 200 West Areas, a much shorter shipping distance than from the 300 Area. For intra-200 West Area shipments (for example, from the Central Waste Complex

[CWC] to the Waste Receiving and Processing Facility [WRAP] or the T Plant Complex to the Low Level Burial Grounds [LLBGs]), a distance of 1 mile (1.6 km) was assumed, and the 200 West Area population density was used. For shipments from the 200 West Area to offsite treatment facilities, a 48-km (30-mi) shipping distance was used. The shipments were assumed to travel 3.2 km (2 mi) in the 300 Area population density region, 6.4 km (4 mi) in the 200 West Area region, and 38.4 km (24 mi) in the 600 Area. ILAW shipments to a 200 East Area disposal facility were modeled as a 1.6 km (1 mi) shipment, 10 percent of which is through an area defined by a population density of 660 persons/km^2 (1700 persons/mi^2) and 90 percent in an area defined by a population density of 0.14 persons/km^2 (0.35 persons/mi^2). ILAW shipments to a 200 West Area disposal facility were modeled as a 16-km (10-mi) shipment, 10 percent of which is through an area defined by a population density of 660 persons/km^2 (1700 persons/mi^2) and 90 percent in an area defined by a population density of 0.14 persons/km^2 (0.35 persons/mi^2).

Table H-2 presents the shipping data for Alternative Group A, Hanford Only waste volume. The table provides the origin and destination for each shipment, the projected waste volume, and the number of shipments. For Alternative Group A, Lower Bound and Upper Bound volume cases, additional wastes are received from offsite generators. The impacts of the shipments from offsite generators are discussed separately in Section H.5. They are not added to the Hanford Only waste-volume case because the analyses of offsite shipments were conducted only for transport through Washington and Oregon.

Shipping data for Alternative Group B is similar to Group A except for ILAW and MLLW shipments. In Group B, the ILAW disposal facility is assumed to be located in the 200 West Area (was assumed to be located near PUREX in Group A); consequently, the shipping distance for ILAW canisters is longer in Alternative Group B than Group A. For MLLW, wastes that were assumed to be shipped offsite are instead shipped to a new treatment facility assumed to be located in the 200 West Area. This significantly reduces the shipping distances for these wastes in Alternative Group B.

Shipping data for Alternative Group C is similar to Group A. The differences between Group C and A are in the technologies deployed to treat and dispose of the waste. For example, LLW is assumed to be disposed in a single, expandable unlined trench in Group C whereas it is disposed of in deeper, wider, lined trenches in Group A. Both the expandable and deeper, wider, unlined disposal facilities are assumed to be located in the 200 West Area, and therefore there would be only minimal differences in shipping data between the two Alternative Groups. Similarly, MLLW is assumed to be disposed in a single expandable lined trench in Group C and deeper, wider lined trenches in Group A. Because both types of lined-trench disposal facilities are assumed to be located in the 200 East Area, there would be no differences in shipping data.

Alternative Group A also forms the base for Alternative Groups D and E. The main differences between these alternatives and the effects on shipping data are as follows. Treatment of all waste types is identical in all three Groups. The difference between the three Alternative Groups is in the location of disposal facilities for LLW (three locations in or near the 200 East Area in Alternative Group D versus 200 West Area for Group A). Because most of these wastes were assumed to be transported from the 300 Area to 200 Area disposal facilities to bound the impacts, the exact locations of the disposal facilities have little impact on the results.

Table H.2. Shipping Data – Alternative Group A, Hanford Only Waste Volume

Waste Stream	Origin	Destination	Waste Volume, m^3	Number of Shipments[(a)]
		LLW		
WRAP				
1b - LLW Cat. 1	300 Area	WRAP	3326	443
2c - LLW Cat. 3	300 Area	WRAP	1462	430
T Plant Complex				
1b2 - LLW Cat. 1	WRAP	T-Plant	274	37
2c2 - LLW Cat. 3	WRAP	T-Plant	143	42
Offsite Commercial Facilities	CWC	Comm Treat	299	40
Repackage in HICs or Trench Grouting				
2a - LLW Cat 3 Direct Disposal	300 Area	LLBG	35,372	10,404
2c1 - LLW Cat 3 from WRAP	WRAP	LLBG	1318	388
2c2 - LLW Cat 3 from T Plant	T-Plant	LLBG	214	63
LLBG				
1a - LLW Cat 1 Direct Disposal	300 Area	LLBG	66,522	8870
1a - LLW Cat 1 from stream 11	300 Area	LLBG	158	21
1b1 - LLW Cat 1 from WRAP	WRAP	LLBG	3034	405
1b2 - LLW Cat 1 from T Plant	T-Plant	LLBG	411	55
6 - Non-Conforming LLW	Comm Treat	LLBG	598	80
		MLLW		
WRAP				
11 - Wastes ready for disposal	300 Area	WRAP	187	55
13 - Waste verification	CWC	WRAP	2684	789
13 - Post treatment verification	WRAP	CWC	2684	789
MLLW reclassified as LLW	WRAP	LLBG	18	5
Modified T Plant				
12 - RH MLLW	CWC	T-Plant	2839	4732
Commercial Treatment Facilities				
13A - CH Standard (non-thermal)	CWC	Offsite	20,108	2801
13B - CH Standard (thermal)	CWC	ORR	6727	946
14 - Elemental Lead	CWC	Offsite	600	1200
15 - Elemental Mercury	CWC	Offsite	21	42
MW Enhanced Trench Design				
11 - Wastes ready for disposal	300 Area	MW Trench	26,682	7848
22 - WTP Melters	200E Area	MW Trench	3205	18
11 - From WRAP verification	WRAP	MW Trench	187	55
12 - RH MLLW from Modified T Plant	T-Plant	MW Trench	4066	6777
13A - CH Standard (non-thermal)	Offsite	MW Trench	36,195	5602
13B - CH Standard (thermal)	ORR	MW Trench	6054	946
14 - Elemental Lead	Offsite	MW Trench	1200	2400
15 - Elemental Mercury	Offsite	MW Trench	42	84

Table H2. (contd)

Waste Stream	Origin	Destination	Waste Volume, m^3	Number of Shipments[(a)]
TRU				
WRAP				
4A - Retrievably Stored Drums in Trenches	LLBG	WRAP	3714	1092
9 - Drums	300 Area	WRAP	5933	1745
9 - SWBs	300 Area	WRAP	20,937	3673
Storage in T Plant Complex				
#17 - K-Basin Sludge	K-Basin	T-Plant	139	41
WIPP	See Section H.5			
LLBG				
4A - TRU drums assayed in trench as LLW				
4A - Empty containers sent to LLBG for disposal	WRAP	LLBG	371	49
9 - drums assayed in WRAP as LLW	WRAP	LLBG	305	41
10A - Newly generated CH Non-standard	300 Area	CWC	492	145
10B - Newly-generated RH Waste	300 Area	CWC	2112	3520
10 - TRU Waste Processed at T-Plant	T-Plant	LLBG	215	29
ILAW				
Immobilized Low Activity Waste	WTP	200 E Disposal	211,000	97,235

(a) Due to rounding, the number of shipments may not match exactly the result of dividing the volume shipped by the shipment capacity.
RH = remote-handled
CH = contact-handled
LDR = land disposal restriction
WTP = Waste Treatment Plant.
ORR = Oak Ridge Reservation
SWB = Standard Waste Box
NWPF = New Waste Processing Facility

Shipping data for the No Action Alternative is presented in Table H.3. Key differences between the No Action Alternative and the other alternatives are that many waste streams are stored rather than being treated and disposed. This substantially reduces the amount of transportation required to manage solid wastes.

To provide a conservative analysis, waste sent from Hanford for thermal treatment was assumed to go to the Oak Ridge Reservation (ORR). For shipments of waste from Hanford to the ORR for treatment and then back to Hanford for disposal, per-shipment impacts were taken directly from a previous Environmental Assessment (EA) that evaluated the impacts of transporting LLW from the ORR to Hanford (DOE 2001). No adjustments were made to reflect the assumed larger shipping capacities used in the EA (eighty 55-gal drums per shipment in the ORR EA versus 18 drums per shipment assumed in this EIS), except the numbers of shipments were calculated using 18 drums per shipment. Important parameters that remained the same included the radiological inventories, external radiation dose rates, packaging-system release parameters, fractional occurrences of accidents in the various severity categories, and dosimetry parameters. Note that the ORR EA conducted route-specific impact analyses for these

Table H.3. Shipping Data for the No Action Alternative

Waste Stream	Origin	Destination	Volume Shipped, m^3	Number of Shipments[(a)]
		LLW		
WRAP				
1b - LLW Cat. 1	300 Area	WRAP	3326	443
2c - LLW Cat. 3	300 Area	WRAP	1462	430
T-Plant Complex				
1b2 - LLW Cat. 1	WRAP	T-Plant	274	37
2c2 - LLW Cat. 3	WRAP	T-Plant	143	42
Repackage in HICs or Trench Grouting				
2a - LLW Cat 3 Direct Disposal	300 Area	LLBG	35,372	10,404
2c1 - LLW Cat 3 from WRAP	WRAP	LLBG	1318	388
2c2 - LLW Cat 3 from T Plant	T-Plant	LLBG	214	63
LLBG				
1a - LLW Cat 1 Direct Disposal	300 Area	LLBG	66,522	8870
1a - LLW Cat 1 from stream 11	300 Area	LLBG	158	21
1b1 - LLW Cat 1 from WRAP	WRAP	LLBG	3034	405
1b2 - LLW Cat 1 from T Plant	T-Plant	LLBG	411	55
		MLLW		
WRAP				
11 - Wastes ready for disposal	300 Area	WRAP	187	55
13 - Waste verification	CWC	WRAP	2684	789
13 - Post treatment verification	CWC	WRAP	36	11
MLLW reclassified as LLW	WRAP	LLBG	18	5
Commercial Treatment Facilities				
13B - CH Standard (thermal)	CWC	ORR	360	106
MW Existing Trenches				
11 - Wastes ready for disposal	300 Area	MW Trench	25,942	7630
CH-MLLW	CWC	MW Trench		
RH-MLLW	CWC	MW Trench		
11 - From WRAP verification	WRAP	MW Trench	113	33
13B - CH Standard (thermal)	ORR	MW Trench	360	106
14 - Elemental Lead	300 Area	CWC	155	310
15 - Elemental Mercury	300 Area	CWC	8	16
		TRU		
WRAP				
4A - Retrievably Stored Drums in Trenches	LLBG	WRAP	3714	1092
9 - CH - Standard Containers (55-gal drums and SWBs)				
Drums	300 Area	WRAP	5933	1745
SWBs	300 Area	WRAP	20,937	3673
Storage in T Plant Complex				
17 - K-Basin Sludge	K-Basin	T-Plant	139	41
WIPP	Hanford	WIPP	See Section H.5	

Table H3. (contd)

Waste Stream	Origin	Destination	Volume Shipped, m^3	Number of Shipments[(a)]
LLBG				
4A - Empty containers sent to LLBG for disposal	WRAP	LLBG	371	50
9 - drums assayed in WRAP as LLW	WRAP	LLBG	305	41
10A - Newly generated CH Non-standard	300 Area	CWC	492	145
10B - Newly-generated RH Waste	300 Area	CWC	2112	3520

(a) Due to rounding, the number of shipments may not match exactly the result of dividing the volume shipped by the shipment capacity.
RH = remote-handled
CH = contact-handled
LDR = land disposal restriction
WTP = Waste Treatment Plant.
ORR = Oak Ridge Reservation
SWB = Standard Waste Box
NWPF = New Waste Processing Facility

shipments. Also note that the incident-free dose risk to the public and truck crews should be comparable to those calculated here because the external dose rates are assumed to be the same in the ORR EA as they are at Hanford. Radiological accident risks should be slightly higher than those calculated for Hanford because the radionuclide inventories assumed here are for only eighteen 55-gal drums of waste. Those used in the ORR EA assumed eighty 55-gal drums per shipment. Finally, the ORR EA did not estimate the number of accidents projected to occur during the shipments. These impacts were estimated in this EIS by multiplying the estimated non-radiological fatalities due to traffic accidents by the ratio of the mean national accident rate to the mean national fatality rate given by Saricks and Tompkins (1999, Table 4). This ratio amounts to about one fatality per 46 heavy-combination truck accidents. The reader is referred to DOE (2001) for additional information about the ORR shipments. Shipments to non-thermal treatment facilities were assumed to be transported to a facility adjacent to the Hanford Site.

Radiological Accident Risks. RADTRAN 4 performs accident risk assessment by combining the probabilities and consequences of accidents to produce a risk value. RADTRAN 4 considers a spectrum of potential transportation accidents, ranging from those with high frequencies and low consequences (for example, fender benders) to those with low frequencies and high consequences (accidents in which the shipping container is exposed to severe mechanical and thermal conditions).

Accident analysis in RADTRAN 4 is performed using an accident severity and package release model. The user can define up to 20 severity categories for 3 population densities (urban, suburban, and rural), each category increasing in magnitude. Severity categories are related to fire, puncture, crush, and immersion environments created in vehicular accidents. For this study, the eight severity categories defined in NUREG-0170 (NRC 1977) were adopted. Severity Category I represents minor accidents in which the packaging system retains confinement of the cargo (that is, no release). Higher severity categories represent more severe accident conditions with correspondingly higher releases and lower probabilities.

Each severity category has an assigned conditional probability (or the probability, given an accident occurs that it will be of the specified severity). The accident scenarios are further defined by allowing the user to input release fractions and aerosol and respirable fractions for each severity category. These fractions are also a function of the physical-chemical properties of the materials transported. RADTRAN 4 default values for similar generic materials were used in this analysis. For example, Category 1 solid wastes were modeled as a generic small-powder-material form. Using this definition, the Category 1 LLW solids will have an aerosol fraction of 0.10 (that is, 10 percent aerosol-size particles) and a respirable fraction of 0.05 (or 5 percent of the aerosol-size particles are also respirable-size particles). These parameters were used for all onsite shipments of solid materials, including Category 1 LLW, Category 3 LLW, Greater than Class 3 (GTC3) LLW, MLLW, and TRU waste. LLW Category 1 organic liquid wastes were assigned to a generic liquid material form in which the aerosol and respirable fractions are set to 1.0. Table H.4 shows the input parameters used in this analysis of onsite and offsite shipments in 55-gal drums and boxes as well as ILAW canisters. Note that the release fractions used are very conservative for ILAW, which will be transported in a massive steel container that is much less likely to fail in accident conditions than a drum or box shipment. Concentrations of radioactive materials that were used to calculate the per-shipment inventories of each material, taken from the Technical Information Document FH (2003), are shown in Table H.5. Note that only a few streams are presented in Table H.5. Readers are referred to the Technical Information Document (FH 2003) for information on other waste streams.

For accidents that result in a release of radioactive material, RADTRAN 4 assumes the material is dispersed into the environment according to standard Gaussian diffusion models. The code allows the user to choose two different methods for modeling the atmospheric transport of radionuclides after a potential accident. The user can either input Pasquill atmospheric-stability category data or averaged time-integrated concentrations. In this analysis, the default standard cloud option (uses time-integrated concentrations) within RADTRAN 4 was used.

RADTRAN 4 calculates the population dose from the released radioactive material for four exposure pathways. These pathways are

1. external dose from exposure to the passing cloud of radioactive material

2. external dose from radionuclides deposited on the ground by the passing plume

3. internal dose from inhalation of airborne radioactive contaminants

4. internal dose from ingestion of contaminated food.

Standard radionuclide uptake and dosimetry models are incorporated into RADTRAN 4. The computer code combines the accident consequences and frequencies of each severity category, sums over the severity categories, and then integrates over all the shipments. Accident-risk impacts that are provided in the form of a collective population dose (person-rem over the entire shipping campaign) are then converted to population risk using health-effects conversion factors. The dose to risk factors, which

Table H.4. RADTRAN 4 Accident Parameters for Trucks

Accident Rate **Onsite**[a] – Hanford Sitewide Average – 1.14E-7 accidents per mile			
Fractional Occurrence by Severity Category (Conditional Probability Given an Accident Occurs)[a]			
Severity Category			
I	0.55		
II	0.36		
III	0.07		
IV	0.016		
V	0.0028		
VI	0.0011		
VII	8.5E-5		
VIII	1.5E-5		
Fractional Occurrence by Population Zone (Conditional Probability Given an Accident Occurs of the Specified Severity)[a]			
	Rural	**Suburban**	**Urban**
I	0.1	0.1	0.8
II	0.1	0.1	0.8
III	0.3	0.4	0.3
IV	0.3	0.4	0.3
V	0.5	0.3	0.3
VI	0.7	0.2	0.1
VII	0.8	0.1	0.1
VIII	0.9	0.05	0.05
Release Fraction (Fraction of Container Contents Released from Shipment by Severity Category)[b]			
I	0		
II	0.01		
III	0.1		
IV	1		
V	1		
VI	1		
VII	1		
VIII	1		

(a) Data taken from NUREG-0170 (NRC 1977) for Type A shipments (see Text Box on Page H.6).
(b) Source: Green et al. (1996).

Table H.5. Radionuclide Concentrations (Ci/m^3) Used to Calculate Per-Shipment Inventories[(a)]

Radionuclide	LLW Cat 1	LLW Cat 3	MLLW	TRU Waste	ILAW
Am-241	6.41E-6	7.94E-3	0	3.17E+0	1.1E-1
C-14	7.02E-5	2.25E-5	0	0	0
Cm-244	0	1.00E-3	0	0	1.1E-3
Co-60	1.07E-3	5.27E-2	3.18E-8	0	4.4E-2
Cs-137/Ba-137m	1.01E-4	9.77E+0	1.70E-6	8.17E-2	9.6E+0
Fe-55	2.46E-3	5.24E-2	0	0	0
H-3	4.49E+0	1.62E-3	0	0	0
Mn-54	3.29E-3	7.78E-3	0	0	0
Ni-59	2.60E-4	8.87E-6	0	0	1.8E-3
Ni-63	8.62E-4	8.75E-2	0	0	1.7E-1
Pu-238	2.16E-6	1.97E-3	0	7.21E-1	5.1E-4
Pu-239	3.11E-5	9.44E-3	0	2.74E+0	3.2E-2
Pu-240	7.87E-6	3.73E-3	0	1.54E+0	5.5E-3
Pu-241	2.11E-4	2.23E-1	0	5.77E+1	7.5E-2
Pu-242	1.77E-8	1.70E-6	0	6.25E-5	4.7E-7
Sr-90 / Y-90	1.20E-4	1.24E+1	1.60E-7	6.73E-2	4.7E+1
Tc-99	1.37E-5	9.59E-3	1.17E-3	0	1.6E-2
U-233	0	1.49E-5	0	0	1.4E-3
U-234	0	1.89E-2	0	0	4.6E-4
U-235	0	5.40E-4	1.13E-7	0	1.9E-5
U-236	0	2.44E-3	0	0	1.5E-5
U-238	0	3.04E-2	1.18E-4	0	5.1E-4

(a) Source: FH 2003.

were taken from the International Commission on Radiological Protection (ICRP) Publication 60 (ICRP 1991), infer 4.0E-4 latent cancer fatalities (LCFs) per person-rem for workers and 5.0E-4 LCF/person-rem for the general public.

H.1.2 Physical (Non-Radiological) Routine Risks

Non-radiological routine impacts consist of fatalities from pollutants, such as diesel exhaust emitted from vehicles. This category of impacts is not related to the radiological characteristics of the cargo.

Spreadsheet calculations were performed using unit-risk factors (fatalities per km of travel) to derive estimates of the non-radiological impacts. The non-radiological impacts were calculated by multiplying the unit risk factors by the total shipping distances for all of the shipments in each shipping option. Non-radiological unit risk factors for incident-free transport were taken from Rao et al. (1982).

H.1.3 Non-Radiological Accident Risks in Transit

The non-radiological accident impacts of traffic accidents associated with the transportation of radioactive waste are assumed to be comparable to the impacts associated with general transportation activities in the United States. A unit factor (fatalities per km or fatalities per mi) is multiplied by the shipping distance to calculate non-radiological impacts from vehicular accidents. The fatalities are due to vehicular impacts with solid objects, rollovers, or collisions and are not related to the radioactive nature of the cargo being transported. For onsite shipments, the fatality data developed by Saricks and Tompkins (1999) for primary highways in the state of Washington was used in the calculations. Separate unit factors were used to develop estimates of the number of accidents involving the shipments and the number of fatalities resulting from the accidents.

H.1.4 Hazardous Chemical Impact Analysis

The impact of accidental releases of hazardous chemicals from the various waste shipments was addressed differently than accidental releases of LLW, MLLW, and TRU waste. A maximum credible accident involving each shipment was postulated. Hazardous chemical release and atmospheric dispersion calculations were then performed to determine the maximum downwind concentration to which an individual would be exposed. The downwind concentrations were compared to safe exposure levels for each chemical (Emergency Response Planning Guidelines [ERPGs] or Temporary Emergency Exposure Limits [TEELs]; see Section H.6) to determine the potential public and worker impacts.

The formula used to estimate the downwind concentrations of hazardous chemicals is

$$Concentration = \frac{Source\ Inventory \times Respirable\ Release\ Fraction \times \frac{E}{Q}}{Release\ Duration}$$

where E/Q is the atmospheric dispersion coefficient.

Hazardous chemical concentrations for the highest-volume waste streams are presented in Table H.5.

Source inventories for each material shipped were taken from the Technical Information Document (FH 2003). Where necessary, adjustments were made to the 55-gal drum inventories in Table H.6 to account for different waste container sizes and shipment capacities. Release duration was assumed in all cases to be 2 hr. Derivations of the remaining variables in the formula are described in the following paragraphs.

Table H.6. Maximum Hazardous Chemical Inventories

Hazardous Constituent	TEEL-2 Value (mg/m³)[(a)]	Chemical Inventory in Maximum 55-Gallon Drum,[(b)] kg			
		MLLW[(c)]	TRU Waste[(d)]	Elemental Mercury	Elemental Lead
Acetone	8500	20.0	0	0	0.2
Ammonium fluoride	12.5	7.9	0	0	0
Ammonium nitrate	50	7.9	0	0	0
Ammonium sulfate	500	15.6	0	0	0
Beryllium	0.025	5.7	0.2	0	0
Butyl alcohol	50	1.1	0.5	0	0
Carbon tetrachloride	100	36.6	1.0	0	0
Cyclohexane	1300	3.8	0	0	0
Ethanol	3300	20.2	0.2	0	0
Hydrazine	0.8	8.6	0	0	0
Isopropyl alcohol	400	29.1	0	0	0
Lead	0.25	0	0	0	204
Mercury	0.1	0	0	27.6	0
Methanol	1000	39.2	0	0	0
Methyl ethyl ketone (MEK)	0.2	23.8	0	0	0
Methyl isobutyl ketone	500	33.0	0	0	0
Nitric acid	15	61.0	0.2	0	0
Phosphoric acid	500	52.4	0.3	0	0
Potassium hydroxide	2	56.3	0	0	0
Propane	2100	0	0.4	0	0
Sodium Hydroxide	40	76.5	6.0	0	0
Styrene	250	1.6	0	0	0
Sulfuric acid	10	3.3	1.5	0	0
Tetrahydrofuran	2000	3.0	0	0	0
Toluene	300	104.0	0	0	0
Uranium	1	340	0	0	0
Xylene	200	52.0	4.2	0	0

Note: 0 indicates no data was provided in the source document.
(a) Source: Craig (2001).
(b) Source: FH (2003).
(c) The source terms are representative of CH MLLW. RH MLLW had a lower hazardous chemical content.
(d) The source term is representative of suspect TRU waste in trenches. Other TRU waste chemical source terms were lower.

The maximum credible accident postulated here is assumed to involve a severe impact followed by a fire. The impact condition is assumed to break up the waste form and cause the waste container to fail so the contained material has an open pathway to the environment. A fire is then assumed to occur, resulting in additional damage and turning the waste material into an aerosol. The aerosol and respirable fractions, used for the radiological materials (for example, with LLW Category 1), were set equal to 0.1 and 0.05, respectively, and were also used to characterize the released hazardous chemicals. Therefore, a combined respirable release fraction of 0.005 was used in the calculations.

Because an accident could occur anywhere and at any time during a shipment, predicting the population distributions and weather conditions at the time of the accident is not possible. For this analysis, the concentrations of the hazardous materials at the location of the maximally exposed individual were calculated. The maximally exposed individual (MEI) for onsite shipments was assumed to be a Hanford Site worker located 100 m (109 yd) downwind from the accident location for the entire duration of the release. The dose to the MEI for offsite shipments would be similar. Downwind air concentrations are also a function of wind speed and atmospheric stability class. Accident-analysis guidance from the U.S. Nuclear Regulatory Commission (NRC) was used to characterize the weather conditions at the time of the accident. The wind speed was assumed to be 1 m/s, and Pasquill stability class F (stable conditions) was assumed. These are low-probability wind conditions that tend to overestimate typical concentrations of released materials. The atmospheric dispersion coefficient or E/Q was calculated using NRC Regulatory Guide 1.145 (NRC 1982). The atmospheric dispersion coefficient at 100 m (109 yd) under Pasquill stability class F and 1 m/s wind speed was calculated to be 3.5E-2 s/m^3.

The impacts to the maximum exposed individual were determined by comparing the downwind concentrations of each hazardous chemical to safe exposure levels. The primary source of the exposure levels is Craig (2001), *ERPGs and TEELs for Chemicals of Concern, Rev. 18*. The safe exposure level assumed here is the TEEL-2 (Temporary Emergency Exposure Limit - 2), as defined by Craig (2001). The TEEL-2 concentration is defined as the maximum concentration in air below which nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.

H.2 Results of Transportation-Impact Analysis

This section presents the results of the transportation-impact analysis in support of the EIS. Separate subsections are presented for results of Alternative Groups A through E and the No Action Alternative. The accident-impact analysis results for hazardous chemicals are presented in Section H.6. All of the impacts provided in the table are in fatalities except for the estimated number of traffic accidents. Fatalities are expressed in latent cancer fatalities (LCFs) for radiological impacts and routine non-radiological emissions. For non-radiological accidents, impacts are expressed in terms of the predicted number of traffic accidents and physical-trauma-induced fatalities resulting from the traffic accidents. Note that many of the entries in the table are expressed as fractional fatalities, for example, 1E-1 or 0.1 fatalities. The whole-number totals are determined by summing over all waste types and then rounding the sums to the nearest whole number.

H.2.1 Alternative Group A

The transportation impacts for Alternative Group A, Hanford Only volume is presented in Table H.7. The impacts of shipments from offsite generators, which make up the differences between the Hanford Only, Lower Bound, and Upper Bound waste-volume cases, are addressed in Section H.5.

H.2.2 Alternative Group B

Table H.8 presents the impacts of transporting MLLW under Alternative Group B, Hanford Only waste volume. Note that the shipping parameters for transportation of LLW, TRU waste, and ILAW are the same in this alternative as they are in Alternative Group A. Thus, only the MLLW impacts are presented in Table H.8. Also note that the impacts of shipments from offsite generators, which make up the differences between the Hanford Only, Lower Bound, and Upper Bound waste-volume cases, are addressed in Section H.5.

H.2.3 Alternative Group C

The results of the impact analysis for transport of solid waste under the Alternative Group C are the same as those for Alternative Group A because there are no substantial differences in shipping parameters. Treatment and disposal facilities are located in the same areas of the Hanford Site in both alternatives. Since most of these wastes were assumed to be transported from the 300 Area to 200 Area disposal facilities to bound the impacts, the exact locations of the disposal facilities have little impact on the results.

H.2.4 Alternative Group D

The results of the impact analysis for transport of solid waste under the Alternative Group D are the same as those for Alternative Group A because there are no substantial differences in shipping parameters. See Section H.2.3.

H.2.5 Alternative Group E

The results of the impact analysis for transport of solid waste under the Alternative Group E are the same as those for Alternative Group A because there are no substantial differences in shipping parameters. See Section H.2.3.

H.2.6 No Action Alternative

Table H.9 presents the transportation impacts of the No Action Alternative.

Table H.7. Transportation Impacts of Alternative Group A, Hanford Only Waste Volume[(a)], Number of Fatalities

Waste Stream	Radiological Incident-Free LCFs		Radiological Accident LCFs	Non-radiological Accidents		
	Occupational	Non-Occupational		Number of Accidents	Number of Fatalities	Emissions LCFs
LLW						
WRAP						
1b - LLW Cat. 1	6.3E-04	5.3E-04	2.1E-05	4.0E-03	4.4E-04	3.5E-03
2c - LLW Cat. 3	6.1E-04	5.2E-04	7.2E-04	3.9E-03	4.3E-04	3.4E-03
T Plant Complex						
1b2 - LLW Cat. 1	6.0E-06	1.2E-05	8.3E-07	1.3E-05	1.5E-06	1.2E-05
2c2 - LLW Cat. 3	6.9E-06	1.4E-05	3.6E-05	1.5E-05	1.7E-06	1.3E-05
Offsite Commercial Facilities	2.4E-05	4.8E-05	5.3E-10	4.4E-04	4.8E-05	3.8E-04
Repackage in HICs or Trench Grouting						
2a - LLW Cat 3 Direct Disposal	1.5E-02	1.2E-02	1.7E-02	9.5E-02	1.0E-02	8.2E-02
2c1 - LLW Cat 3 from WRAP	6.4E-05	1.3E-04	3.3E-04	1.4E-04	1.6E-05	1.2E-04
2c2 - LLW Cat 3 from T Plant	1.0E-05	2.1E-05	5.4E-05	2.3E-05	2.5E-06	2.0E-05
LLBG						
1a - LLW Cat 1 Direct Disposal	1.3E-02	1.1E-02	4.2E-04	8.1E-02	8.9E-03	7.0E-02
1a - LLW Cat 1 from stream 11	3.0E-05	2.5E-05	9.9E-07	1.9E-04	2.1E-05	1.7E-04
1b1 - LLW Cat 1 from WRAP	6.7E-05	1.4E-04	9.2E-06	1.5E-04	1.6E-05	1.3E-04
1b2 - LLW Cat 1 from T Plant	9.0E-06	1.8E-05	1.2E-06	2.0E-05	2.2E-06	1.7E-05
6 - Non-Conforming LLW	4.8E-05	9.6E-05	1.1E-09	8.7E-04	9.6E-05	7.6E-04
TOTAL LLW	**2.9E-02**	**2.5E-02**	**1.9E-02**	**1.9E-01**	**2.0E-02**	**1.6E-01**
MLLW						
WRAP						
11 - Wastes ready for disposal	7.8E-05	6.6E-05	2.6E-06	5.0E-04	5.5E-05	4.4E-04
13 - Waste verification	1.3E-04	2.6E-04	1.8E-05	2.9E-04	3.2E-05	2.5E-04
13 - Post treatment verification	1.3E-04	2.7E-04	1.8E-05	2.9E-04	3.2E-05	2.5E-04
MLLW reclassified as LLW	8.7E-07	1.8E-06	1.2E-07	1.9E-06	2.1E-07	1.7E-06
Modified T Plant						
12 - RH MLLW	7.8E-04	1.5E-03	1.1E-03	1.7E-03	1.9E-04	1.5E-03
Commercial Treatment Facilities						
13A - CH Standard (non-thermal)	2.3E-01	5.5E-02	2.1E-07	1.2E+01	2.8E-01	1.2E-02
13B - CH Standard (thermal)	7.7E-02	1.9E-02	6.9E-08	3.9E+00	9.5E-02	3.9E-03
14 - Elemental Lead	0	0	0	1.3E-02	1.4E-03	1.1E-02
15 - Elemental Mercury	0	0	0	4.6E-04	5.0E-05	4.0E-04

Table H7. (contd)

Waste Stream	Radiological Incident-Free LCFs		Radiological Accident LCFs	Non-radiological Accidents		
	Occupational	Non-Occupational		Number of Accidents	Number of Fatalities	Emissions LCFs
MW Enhanced Trench Design						
11 - Wastes ready for disposal	1.1E-02	9.4E-03	3.7E-04	7.2E-02	7.8E-03	6.2E-02
22 - WTP Melters	3.0E-05	5.9E-05	4.2E-05	6.7E-06	7.3E-07	5.8E-06
11 - From WRAP verification	9.1E-06	1.8E-05	1.3E-06	2.0E-05	2.2E-06	1.7E-05
12 - RH MLLW from Modified T Plant	1.1E-03	2.2E-03	1.5E-03	2.5E-03	2.7E-04	2.1E-03
13A - CH Standard (non-thermal)	9.2E-03	8.1E-03	3.2E-04	6.1E-02	6.7E-03	5.3E-02
13B - CH Standard (thermal)	7.7E-02	1.9E-02	6.9E-08	3.9E+00	9.5E-02	3.9E-03
14 - Elemental Lead	0	0	0	2.6E-02	2.9E-03	2.3E-02
15 - Elemental Mercury	0	0	0	9.2E-04	1.0E-04	8.0E-04
TOTAL MLLW	**4.1E-01**	**1.1E-01**	**3.4E-03**	**2.0E+01**	**4.9E-01**	**1.7E-01**
TRU						
WRAP						
4A - Retrievably Stored Drums in Trenches	1.8E-04	3.5E-04	3.5E-04	4.0E-04	4.4E-05	3.5E-04
9 - Drums	2.5E-03	2.1E-03	1.2E-03	1.6E-02	1.7E-03	1.4E-02
9 - SWBs	5.2E-03	4.4E-03	2.5E-03	3.3E-02	3.7E-03	2.9E-02
Storage in T Plant Complex						
#17 - K-Basin Sludge	4.9E-05	3.2E-05	2.3E-06	1.1E-04	1.2E-05	9.7E-05
WIPP						
LLBG	**See Section H.5**					
4A - TRU drums assayed in trench as LLW						
4A - Empty containers sent to LLBG for disposal	8.2E-06	1.7E-05	1.1E-06	1.8E-05	2.0E-06	1.6E-05
9 - drums assayed in WRAP as LLW	6.7E-06	1.4E-05	9.3E-07	1.5E-05	1.6E-06	1.3E-05
10A - Newly generated CH Non-standard	2.4E-05	4.7E-05	3.3E-06	5.3E-05	5.8E-06	4.6E-05
10B - Newly-generated RH Waste	5.8E-04	1.1E-03	8.0E-04	1.3E-03	1.4E-04	1.1E-03
10 - TRU Waste Processed at T-Plant	4.7E-06	9.6E-06	6.5E-07	1.0E-05	1.1E-06	9.1E-06
TOTAL TRU WASTE	**8.6E-03**	**8.1E-03**	**4.9E-03**	**5.1E-02**	**5.6E-03**	**4.5E-02**
ILAW						
Immobilized Low Activity Waste	**5.8E-03**	**1.9E-04**	**3.7E-11**	**3.5E-02**	**3.8E-03**	**3.0E-03**
GRAND TOTAL	**4.5E-01**	**1.5E-01**	**2.7E-02**	**2.0E+01**	**5.2E-01**	**3.8E-01**

Table H.8. MLLW[(a)] Transportation Impacts of Alternative Group B, Hanford Only Waste Volume, Number of Fatalities

Waste Stream	Radiological Impacts, LCFs		Radiological Accidents	Non-Radiological Impacts		
	Occupa-tional	Non-Occupational		Number of Accidents	Accident Fatalities	Emission, LCFs s
MLLW						
WRAP						
11 - Wastes ready for disposal	7.8E-05	6.6E-05	2.6E-06	5.0E-04	5.5E-05	4.4E-04
13 - Waste verification	1.3E-04	2.6E-04	1.8E-05	2.9E-04	3.2E-05	2.5E-04
13 - Post treatment verification	1.3E-04	2.7E-04	1.8E-05	2.9E-04	3.2E-05	2.5E-04
MLLW reclassified as LLW	8.7E-07	1.8E-06	1.2E-07	1.9E-06	2.1E-07	1.7E-06
Modified T Plant						
12 - RH MLLW	7.8E-04	1.5E-03	1.1E-03	1.7E-03	1.9E-04	1.5E-03
Commercial Treatment Facilities						
13A - CH Standard (non-thermal)	1.3E-03	2.5E-03	1.8E-04	2.8E-03	3.1E-04	2.5E-03
13B - CH Standard (thermal)	4.1E-03	1.0E-03	3.7E-09	2.1E-01	5.1E-03	2.1E-04
14 - Elemental Lead	0	0	0	2.7E-04	3.0E-05	2.4E-04
15 - Elemental Mercury	0	0	0	9.6E-06	1.1E-06	8.3E-06
MW Enhanced Trench Design						
11 - Wastes ready for disposal	1.1E-02	9.4E-03	3.7E-04	7.2E-02	7.8E-03	6.2E-02
22 - WTP Melters	3.0E-05	5.9E-05	4.2E-05	6.7E-06	7.3E-07	5.8E-06
11 - From WRAP verification	9.1E-06	1.8E-05	1.3E-06	2.0E-05	2.2E-06	1.7E-05
12 - RH MLLW from Modified T Plant	1.1E-03	2.2E-03	1.5E-03	2.5E-03	2.7E-04	2.1E-03
13A - CH Standard (non-thermal)	2.3E-03	4.4E-03	3.1E-04	5.0E-03	5.5E-04	4.3E-03
13B - CH Standard (thermal)	4.1E-03	1.0E-03	3.7E-09	2.1E-01	5.1E-03	2.1E-04
14 - Elemental Lead	0	0	0	5.5E-04	6.0E-05	4.8E-04
15 - Elemental Mercury	0	0	0	1.4E-04	1.6E-05	1.2E-04
TOTAL MLLW	**2.5E-02**	**2.3E-02**	**3.6E-03**	**5.1E-01**	**2.0E-02**	**7.5E-02**

Table H.9. Transportation Impacts for the No Action Alternative[a], Hanford-only Waste Volume, Number of Fatalities

Waste Type	Radiological Incident-Free Impacts, LCFs		Radio-Logical Accidents LCFs	Non-radiological		
	Occupational	Non-Occupational		Number of Accidents	Accident Fatalities	Emissions, LCFs
LLW						
WRAP						
1b - LLW Cat. 1	6.3E-04	5.3E-04	2.1E-05	4.0E-03	4.4E-04	3.5E-03
2c - LLW Cat. 3	6.1E-04	5.2E-04	7.2E-04	3.9E-03	4.3E-04	3.4E-03
T-Plant Complex						
1b2 - LLW Cat. 1	6.0E-06	1.2E-05	8.3E-07	1.3E-05	1.5E-06	1.2E-05
2c2 - LLW Cat. 3	6.9E-06	1.4E-05	3.6E-05	1.5E-05	1.7E-06	1.3E-05
Repackage in HICs or Trench Grouting						
2a - LLW Cat 3 Direct Disposal	1.5E-02	1.2E-02	1.7E-02	9.5E-02	1.0E-02	8.2E-02
2c1 - LLW Cat 3 from WRAP	6.4E-05	1.3E-04	3.3E-04	1.4E-04	1.6E-05	1.2E-04
2c2 - LLW Cat 3 from T Plant	1.0E-05	2.1E-05	5.4E-05	2.3E-05	2.5E-06	2.0E-05
LLBG						
1a - LLW Cat 1 Direct Disposal	1.3E-02	1.1E-02	4.2E-04	8.1E-02	8.9E-03	7.0E-02
1a - LLW Cat 1 from stream 11	3.0E-05	2.5E-05	9.8E-07	1.9E-04	2.1E-05	1.7E-04
1b1 - LLW Cat 1 from WRAP	6.7E-05	1.4E-04	9.2E-06	1.5E-04	1.6E-05	1.3E-04
1b2 - LLW Cat 1 from T Plant	9.0E-06	1.8E-05	1.2E-06	2.0E-05	2.2E-06	1.7E-05
TOTAL LLW	**2.9E-02**	**2.5E-02**	**1.9E-02**	**1.8E-01**	**2.0E-02**	**1.6E-01**
MLLW						
WRAP						
11 - Wastes ready for disposal	7.8E-05	6.6E-05	2.6E-06	5.0E-04	5.5E-05	4.3E-04
13 - Waste verification	1.3E-04	2.6E-04	1.8E-05	2.9E-04	3.2E-05	2.5E-04
13 - Post treatment verification	1.7E-06	3.6E-06	2.4E-07	3.9E-06	4.2E-07	3.4E-06
MLLW reclassified as LLW	8.5E-07	1.7E-06	1.2E-07	1.9E-06	2.1E-07	1.6E-06
Commercial Treatment Facilities						
13B - CH Standard (thermal)	1.3E-02	2.5E-03	9.4E-09	4.5E-01	1.1E-02	4.5E-04
MW Existing Trenches						
11 - Wastes ready for disposal	1.1E-02	9.2E-03	3.6E-04	7.0E-02	7.6E-03	6.0E-02
11 - From WRAP verification	5.5E-06	1.1E-05	7.6E-07	1.2E-05	1.3E-06	1.1E-05
13B - CH Standard (thermal)	1.3E-02	2.5E-03	9.4E-09	4.5E-01	1.1E-02	4.5E-04
14 - Elemental Lead	0	0	0	2.8E-03	3.1E-04	2.5E-03

Table H9. (contd)

Waste Type	Radiological Incident-Free Impacts, LCFs		Radio-Logical Accidents LCFs	Non-radiological		
	Occupational	**Non-Occupational**		**Number of Accidents**	**Accident Fatalities**	**Emissions, LCFs**
15 - Elemental Mercury	0	0	0	1.5E-04	1.6E-05	1.3E-04
TOTAL MLLW	**3.7E-02**	**1.5E-02**	**3.8E-04**	**9.6E-01**	**2.9E-02**	**6.5E-02**
TRU						
WRAP						
4A - Retrievably Stored Drums in Trenches	1.8E-04	3.5E-04	3.5E-04	4.0E-04	4.4E-05	3.5E-04
9 - CH - Standard Containers (55-gal drums and SWBs)						
Drums	2.5E-03	2.1E-03	1.2E-03	1.6E-02	1.7E-03	1.4E-02
SWBs	5.2E-03	4.4E-03	2.5E-03	3.3E-02	3.7E-03	2.9E-02
Storage in T Plant Complex						
17 - K-Basin Sludge	4.9E-05	3.2E-05	2.3E-06	1.1E-04	1.2E-05	9.7E-05
WIPP	See Section H.5					
LLBG						
4A - Empty containers sent to LLBG for disposal	8.2E-06	1.7E-05	1.1E-06	1.8E-05	2.0E-06	1.6E-05
9 - drums assayed in WRAP as LLW	6.7E-06	1.4E-05	9.3E-07	1.5E-05	1.6E-06	1.3E-05
10A - Newly generated CH Non-standard	2.4E-05	4.7E-05	3.3E-06	5.3E-05	5.8E-06	4.6E-05
10B - Newly-generated RH Waste	5.8E-04	1.1E-03	8.0E-04	1.3E-03	1.4E-04	1.1E-03
TOTAL TRU WASTE	**8.6E-03**	**8.1E-03**	**4.9E-03**	**5.1E-02**	**5.6E-03**	**4.5E-02**
ILAW	Inter-facility transfer					
GRAND TOTAL	**7.5E-02**	**4.7E-02**	**2.4E-02**	**1.2E+00**	**5.5E-02**	**2.7E-01**

H.2.6 Summary of Impacts

Table H.10 summarizes the radiological and non-radiological impacts of each Alternative Group. The results in the table indicate that Alternative Group B results in the lowest transportation impacts of all the alternatives. This is because most MLLW is treated onsite in this alternative so there are fewer offsite shipments of MLLW in Alternative Group B than were projected in the other Alternative Groups. Note that none of the alternatives is projected to result in any radiological fatalities. Only Alternative Group B is projected to result in a non-radiological fatality due to a traffic accident (recall that Group B includes

Table H.10. Summary of Impacts of Shipping Hanford Only Wastes for Each Alternative Group[(a)]

Waste Type	Radiological Impacts, LCFs			Non-Radiological Impacts		
	Occupational	Non-Occupational	Radiological Accidents	Number of Accidents	Accident Fatalities	Emissions, LCFs
Alternative Groups A, C, D, and E[(b)]						
LLW	2.9E-2	2.5E-2	1.9E-2	1.9E-1	2.0E-2	1.6E-1
MLLW	4.1E-1	1.1E-1	3.4E-3	2.0E+1	4.9E-1	1.7E-1
TRU Waste	8.0E-3	6.9E-3	4.1E-3	5.0E-2	5.5E-3	4.3E-2
ILAW	5.8E-3	1.9E-4	3.7E-11	3.5E-2	3.8E-3	3.0E-3
Total	**0** (4.5E-1)	**0** (1.5E-1)	**0** (2.7E-2)	**20** (2.0E+1)	**1** (5.2E-1)	**0** (3.8E-1)
Alternative Group B[(b)]						
LLW	2.9E-2	2.5E-2	1.9E-2	1.9E-1	2.0E-2	1.6E-1
MLLW	2.5E-2	2.3E-2	3.6E-3	5.1E-1	2.0E-2	7.5E-2
TRU Waste	8.0E-3	6.9E-3	4.1E-3	5.0E-2	5.5E-3	4.3E-2
ILAW	5.8E-3	1.9E-4	3.7E-11	3.5E-2	3.8E-3	3.0E-3
Total	**0** (6.9E-2)	**0** (5.6E-2)	**0** (2.7E-2)	**1** (7.8E-1)	**0** (4.9E-2)	**0** (2.8E-1)
No Action Alternative						
LLW	2.9E-2	2.5E-2	1.9E-2	1.8E-1	2.0E-2	1.6E-1
MLLW	3.7E-2	1.5E-2	3.8E-4	9.6E-1	2.9E-2	6.5E-2
TRU Waste	8.6E-3	8.1E-3	4.9E-3	5.1E-2	5.6E-3	4.5E-2
Total[(c)]	**0** (7.5E-2)	**0** (4.7E-2)	**0** (2.4E-2)	**1** (1.2E+0)	**0** (5.5E-2)	**0** (2.7E-1)

Note: Public includes non-involved workers.
(a) Radiological impacts (incident-free and accident) are expressed in units of LCFs. Non-radiological accident impacts are expressed as the expected number of accidents and the resulting physical trauma fatalities. Non-radiological emissions impacts are expressed as LCFs.
(b) The impacts in these areas are for the Hanford Only waste volume case. Impacts are included for shipments of MLLW to offsite treatment facilities and back. The impacts in Washington and Oregon from offsite shipments are presented in Table 5.16.
(c) No transportation impacts are included for transfer of ILAW cullet between the WTP and the adjacent grout vault used for ILAW disposal because of their close proximity.

offsite shipments of MLLW to the ORR for treatment and then return of the treated waste to Hanford). Even so, the differences in impacts among the alternatives are small.

H.3 Impacts of Transporting Construction and Capping Materials

This section evaluates the impacts of transporting materials required to construct new facilities, such as new disposal trenches and treatment facilities, as well as materials required to cap the disposal facilities after they are filled with waste. The quantities of these materials, which include concrete, asphalt, basalt, and concrete, are compiled for each alternative in Section 5.10. This section evaluates the impacts of transporting these materials from their points of origin to the appropriate Hanford Site facility. Note that only the non-radiological impacts of transportation accidents are evaluated. No radiological impacts would occur (Rao et al. 1982).

The non-radiological accident impacts of transporting construction materials were calculated by first determining the numbers of shipments of each material. This calculation was done by dividing the total material requirements by the capacity of a typical shipment. Typically, the shipment capacities are limited to about 40,000 lb (18,140 kg) of cargo to ensure that the shipments are below legal-weight truck limits (80,000 lb [36,290 kg] gross vehicle weight in most states). The next step was to determine the total distance traveled by these shipments or the product of the round-trip shipping distance and the number of shipments. Finally, the projected numbers of fatalities were determined by multiplying the travel distances times the accident and fatality rates for heavy-combination truck shipping. The accident rate used in this analysis was 1.75E-7 accidents per truck-km (2.8E-7 accidents per truck-mile), and the fatality rate was 7.5E-9 fatalities per truck-km (1.2E-8 fatalities per truck-mile). These rates are representative of accident and fatality rates on Washington State primary highways, similar to the highways and roadways to be used for most of the shipments. The rates used in this analysis were taken from Saricks and Tompkins (1999).

Table H.11 presents the input data and results of the impact analysis for the transport of construction and capping materials. The table includes the estimated impacts associated with each Alternative Group and waste-volume case. Although accidents are expected to occur, in no case were any fatalities projected to occur associated with the transport of construction and capping materials.

The results in Table H.11 indicate that there are not large differences in impacts among the Alternative Groups. For the Hanford Only waste-volume cases, the projected fatalities ranged from about 0.06 for Alternative Groups C, D, and E to 0.15 fatalities for the No Action Alternative. The impacts of all Alternative Groups except for the No Action Alternative are dominated by transport of asphalt, gravel/sand, silt/loam, and basalt, and bentonite to use as capping materials. The impacts for the No Action Alternative are dominated by the transport of steel and concrete.

H.4 Impacts on Traffic

The potential for adverse impacts on traffic would be limited to those associated with the transport of construction materials from offsite, which would be predominantly 4- to 6-lane highways south of the Hanford Site; traffic congestion would not be expected. The transport of the majority of capping resources would be onsite as material from Area C would be delivered under State Route (SR) 240 by conveyors to a holding area in Area B on the Hanford Site east of SR 240. For a conservative view, the transportation-impact analysis assumed that all transport of capping material is by truck.

H.5 Offsite Transportation Impacts

This section presents the transportation-impact analysis for shipping LLW and MLLW to Hanford from offsite generators and for shipping TRU Waste to WIPP.

Table H.11. Impacts of Transporting Construction and Backfill Materials

Alternative		Total Material	Shipment Capacity	Total Shipments	Shipment Source	One-way Distance	Total Miles Traveled	Accidents	Fatalities
A	**Hanford Only**								
	Asphalt (1000 m^3)	392	12 m^3	32,667	Offsite	45	2.9E+06	5.1E-01	2.2E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2394	20 m^3	119,700	Area C	15	3.6E+06	6.3E-01	2.7E-02
	Steel (MT)	1720	10 MT	172	Unspecified	1000	3.4E+05	6.0E-02	2.6E-03
	Concrete (1000 m^3)	8	10 m^3	831	Offsite	45	7.5E+04	1.3E-02	5.6E-04
	Bentonite (MT)	13,900	19 MT	732	Wyoming	1000	1.5E+06	2.6E-01	1.1E-02
	TOTAL						8.4E+06	1.5E+00	6.3E-02
	Lower Bound Volume								
	Asphalt (1000 m^3)	394	12 m^3	32,833	Offsite	45	3.0E+06	5.2E-01	2.2E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2405	20 m^3	120,250	Area C	15	3.6E+06	6.3E-01	2.7E-02
	Steel (MT)	1870	10 MT	187	Unspecified	1000	3.7E+05	6.5E-02	2.8E-03
	Concrete (1000 m^3)	10	10 m^3	991	Offsite	45	8.9E+04	1.6E-02	6.7E-04
	Bentonite (MT)	13,900	19 MT	732	Wyoming	1000	1.5E+06	2.6E-01	1.1E-02
	TOTAL						8.5E+06	1.5E+00	6.4E-02
	Upper Bound Volume								
	Asphalt (1000 m^3)	416	12 m^3	34,667	Offsite	45	3.1E+06	5.5E-01	2.3E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2500	20 m^3	125,000	Area C	15	3.8E+06	6.6E-01	2.8E-02
	Steel (MT)	2280	10 MT	228	Unspecified	1000	4.6E+05	8.0E-02	3.4E-03
	Concrete (1000 m^3)	14	10 m^3	1431	Offsite	45	1.3E+05	2.3E-02	9.7E-04
	Bentonite (MT)	18,200	19 MT	958	Wyoming	1000	1.9E+06	3.4E-01	1.4E-02
	TOTAL						9.4E+06	1.6E+00	7.0E-02

Table H.11. (contd)

Alternative		Total Material	Shipment Capacity	Total Shipments	Shipment Source	One-way Distance	Total Miles Traveled	Accidents	Fatalities
B	**Hanford Only**								
	Asphalt (1000 m^3)	438	12 m^3	36,500	Offsite	45	3.3E+06	5.7E-01	2.5E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2552	20 m^3	127,600	Area C	15	3.8E+06	6.7E-01	2.9E-02
	Steel (MT)	1800	10 MT	180	Unspecified	1000	3.6E+05	6.3E-02	2.7E-03
	Concrete (1000 m^3)	10	10 m^3	1021	Offsite	45	9.2E+04	1.6E-02	6.9E-04
	Bentonite (MT)	33,600	19 MT	1768	Wyoming	1000	3.5E+06	6.2E-01	2.7E-02
	TOTAL						1.1E+07	1.9E+00	8.3E-02
	Lower Bound Volume								
	Asphalt (1000 m^3)	444	12 m^3	37,000	Offsite	45	3.3E+06	5.8E-01	2.5E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2593	20 m^3	129,650	Area C	15	3.9E+06	6.8E-01	2.9E-02
	Steel (MT)	1950	10 MT	195	Unspecified	1000	3.9E+05	6.8E-02	2.9E-03
	Concrete (1000 m^3)	12	10 m^3	1231	Offsite	45	1.1E+05	1.9E-02	8.3E-04
	Bentonite (MT)	33,600	19 MT	1768	Wyoming	1000	3.5E+06	6.2E-01	2.7E-02
	TOTAL						1.1E+07	2.0E+00	8.4E-02
	Upper Bound Volume								
	Asphalt (1000 m^3)	498	12 m^3	41,500	Offsite	45	3.7E+06	6.5E-01	2.8E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2827	20 m^3	141,350	Area C	15	4.2E+06	7.4E-01	3.2E-02
	Steel (MT)	2380	10 MT	238	Unspecified	1000	4.8E+05	8.3E-02	3.6E-03
	Concrete (1000 m^3)	16	10 m^3	1631	Offsite	45	1.5E+05	2.6E-02	1.1E-03
	Bentonite (MT)	57,600	19 MT	3032	Wyoming	1000	6.1E+06	1.1E+00	4.5E-02
	TOTAL						1.5E+07	2.6E+00	1.1E-01

Table H.11. (contd)

Alternative		Total Material	Shipment Capacity	Total Shipments	Shipment Source	One-way Distance	Total Miles Traveled	Accidents	Fatalities
C	**Hanford Only**								
	Asphalt (1000 m^3)	372	12 m^3	31,000	Offsite	45	2.8E+06	4.9E-01	2.1E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2174	20 m^3	108,700	Area C	15	3.3E+06	5.7E-01	2.4E-02
	Steel (MT)	1720	10 MT	172	Unspecified	1000	3.4E+05	6.0E-02	2.6E-03
	Concrete (1000 m^3)	8	10 m^3	800	Offsite	45	7.2E+04	1.3E-02	5.4E-04
	Bentonite (MT)	13,900	19 MT	732	Wyoming	1000	1.5E+06	2.6E-01	1.1E-02
	TOTAL						7.9E+06	1.4E+00	5.9E-02
	Lower Bound Volume								
	Asphalt (1000 m^3)	374	12 m^3	31,167	Offsite	45	2.8E+06	4.9E-01	2.1E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2185	20 m^3	109,250	Area C	15	3.3E+06	5.7E-01	2.5E-02
	Steel (MT)	1870	10 MT	187	Unspecified	1000	3.7E+05	6.5E-02	2.8E-03
	Concrete (1000 m^3)	10	10 m^3	960	Offsite	45	8.6E+04	1.5E-02	6.5E-04
	Bentonite (MT)	13,900	19 MT	732	Wyoming	1000	1.5E+06	2.6E-01	1.1E-02
	TOTAL						8.0E+06	1.4E+00	6.0E-02
	Upper Bound Volume								
	Asphalt (1000 m^3)	396	12 m^3	33,000	Offsite	45	3.0E+06	5.2E-01	2.2E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2280	20 m^3	114,000	Area C	15	3.4E+06	6.0E-01	2.6E-02
	Steel (MT)	2280	10 MT	228	Unspecified	1000	4.6E+05	8.0E-02	3.4E-03
	Concrete (1000 m^3)	14	10 m^3	1400	Offsite	45	1.3E+05	2.2E-02	9.5E-04
	Bentonite (MT)	18,200	19 MT	958	Wyoming	1000	1.9E+06	3.4E-01	1.4E-02
	TOTAL						8.9E+06	1.6E+00	6.7E-02

Table H.11. (contd)

Alternative		Total Material	Shipment Capacity	Total Shipments	Shipment Source	One-way Distance	Total Miles Traveled	Accidents	Fatalities
D	**Hanford Only**								
	Asphalt (1000 m^3)	371	12 m^3	30,917	Offsite	45	2.8E+06	4.9E-01	2.1E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2174	20 m^3	108,700	Area C	15	3.3E+06	5.7E-01	2.4E-02
	Steel (MT)	1710	10 MT	171	Unspecified	1000	3.4E+05	6.0E-02	2.6E-03
	Concrete (1000 m^3)	8	10 m^3	800	Offsite	45	7.2E+04	1.3E-02	5.4E-04
	Bentonite (MT)	13,900	19 MT	732	Wyoming	1000	1.5E+06	2.6E-01	1.1E-02
	TOTAL						7.9E+06	1.4E+00	5.9E-02
	Lower Bound Volume								
	Asphalt (1000 m^3)	371	12 m^3	30,917	Offsite	45	2.8E+06	4.9E-01	2.1E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2204	20 m^3	110,200	Area C	15	3.3E+06	5.8E-01	2.5E-02
	Steel (MT)	1870	10 MT	187	Unspecified	1000	3.7E+05	6.5E-02	2.8E-03
	Concrete (1000 m^3)	10	10 m^3	990	Offsite	45	8.9E+04	1.6E-02	6.7E-04
	Bentonite (MT)	13,900	19 MT	732	Wyoming	1000	1.5E+06	2.6E-01	1.1E-02
	TOTAL						8.0E+06	1.4E+00	6.0E-02
	Upper Bound Volume								
	Asphalt (1000 m^3)	383	12 m^3	31,917	Offsite	45	2.9E+06	5.0E-01	2.2E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2331	20 m^3	116,550	Area C	15	3.5E+06	6.1E-01	2.6E-02
	Steel (MT)	2280	10 MT	228	Unspecified	1000	4.6E+05	8.0E-02	3.4E-03
	Concrete (1000 m^3)	14	10 m^3	1400	Offsite	45	1.3E+05	2.2E-02	9.5E-04
	Bentonite (MT)	18,200	19 MT	958	Wyoming	1000	1.9E+06	3.4E-01	1.4E-02
	TOTAL						8.9E+06	1.6E+00	6.7E-02

Table H.11. (contd)

Alternative		Total Material	Shipment Capacity	Total Shipments	Shipment Source	One-way Distance	Total Miles Traveled	Accidents	Fatalities
E	**Hanford Only**								
	Asphalt (1000 m^3)	371	12 m^3	30,917	Offsite	45	2.8E+06	4.9E-01	2.1E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2174	20 m^3	108,700	Area C	15	3.3E+06	5.7E-01	2.4E-02
	Steel (MT)	1710	10 MT	171	Unspecified	1000	3.4E+05	6.0E-02	2.6E-03
	Concrete (1000 m^3)	8	10 m^3	800	Offsite	45	7.2E+04	1.3E-02	5.4E-04
	Bentonite (MT)	13,900	19 MT	732	Wyoming	1000	1.5E+06	2.6E-01	1.1E-02
	TOTAL						7.9E+06	1.4E+00	5.9E-02
	Lower Bound Volume								
	Asphalt (1000 m^3)	371	12 m^3	30,917	Offsite	45	2.8E+06	4.9E-01	2.1E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2185	20 m^3	109,250	Area C	15	3.3E+06	5.7E-01	2.5E-02
	Steel (MT)	1870	10 MT	187	Unspecified	1000	3.7E+05	6.5E-02	2.8E-03
	Concrete (1000 m^3)	10	10 m^3	990	Offsite	45	8.9E+04	1.6E-02	6.7E-04
	Bentonite (MT)	13,900	19 MT	732	Wyoming	1000	1.5E+06	2.6E-01	1.1E-02
	TOTAL						8.0E+06	1.4E+00	6.0E-02
	Upper Bound Volume								
	Asphalt (1000 m^3)	383	12 m^3	31,917	Offsite	45	2.9E+06	5.0E-01	2.2E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2280	20 m^3	114,000	Area C	15	3.4E+06	6.0E-01	2.6E-02
	Steel (MT)	2280	10 MT	228	Unspecified	1000	4.6E+05	8.0E-02	3.4E-03
	Concrete (1000 m^3)	14	10 m^3	1400	Offsite	45	1.3E+05	2.2E-02	9.5E-04
	Bentonite (MT)	18,200	19 MT	958	Wyoming	1000	1.9E+06	3.4E-01	1.4E-02
	TOTAL						8.8E+06	1.5E+00	6.6E-02

Table H.11. (contd)

Alternative		Total Material	Shipment Capacity	Total Shipments	Shipment Source	One-way Distance	Total Miles Traveled	Accidents	Fatalities
No Action	**Hanford Only**								
	Asphalt (1000 m^3)	35	12 m^3	2933	Offsite	45	2.6E+05	4.6E-02	2.0E-03
	Gravel/sand, silt/loam, basalt (1000 m^3)	2648	20 m^3	132,405	Area C	15	4.0E+06	7.0E-01	3.0E-02
	Steel (MT)	59,100	10 MT	5910	Unspecified	1000	1.2E+07	2.1E+00	8.9E-02
	Concrete (1000 m^3)	420	10 m^3	42,000	Offsite	45	3.8E+06	6.6E-01	2.8E-02
	Bentonite (MT)	0	19 MT	0	Wyoming	1000	0	0	0
	TOTAL						2.0E+07	3.5E+00	1.5E-01
	Lower Bound Volume								
	Asphalt (1000 m^3)	35	12 m^3	2933	Offsite	45	2.6E+05	4.6E-02	2.0E-03
	Gravel/sand, silt/loam, basalt (1000 m^3)	2648	20 m^3	132,405	Area C	15	4.0E+06	7.0E-01	3.0E-02
	Steel (MT)	59,200	10 MT	5920	Unspecified	1000	1.2E+07	2.1E+00	8.9E-02
	Concrete (1000 m^3)	422	10 m^3	42,200	Offsite	45	3.8E+06	6.6E-01	2.8E-02
	Bentonite (MT)	0	19 MT	0	Wyoming	1000	0	0	0
	TOTAL						2.0E+07	3.5E+00	1.5E-01

H.5.1 Impacts of Transportation of TRU Wastes to WIPP

This section presents the expected radiological and non-radiological impacts of transporting TRU wastes from Hanford to the WIPP in New Mexico. The information presented in this section was taken from the *Waste Isolation Pilot Plant Disposal Phase Final Environmental Impact Statement* (WIPP SEIS-2, DOE 1997b) adjusted to the Hanford TRU waste volumes projected in this EIS. The WIPP SEIS-2 impacts were adjusted to account for waste volumes projected in this EIS. Table H.12 summarizes the results from the WIPP SEIS-2. Note that the impacts are for the entire route between Hanford and WIPP. The following subsections provide the bases for the values in the table followed by a comparison with the HSW-EIS bases and assumptions.

Waste Volume

The waste volume presented in Table H.12 is for the Action Alternative 1 in the WIPP SEIS-2. It includes both the "Basic Inventory" and "Additional Inventory" of TRU waste projected to be shipped from Hanford to WIPP.

Table H.12. Summary of Impacts of Transporting TRU Waste by Truck from Hanford to WIPP[(a)]

Waste Type	Waste Volume, m^3	Number of Shipments	Radiological Impacts, LCFs[(b)]			Non-Radiological Impacts		
			Routine Occupational	**Routine Non-Occupational**	**Accident Impacts**	**Number of Accidents**	**Fatalities**	**Vehicle Pollution LCFs**
CH-TRU	120,000	18,729	**0** (2.2E-1)	**2** (1.9E+0)	**0** (4.1E-1)	**40** (3.6E+1)	**3** (3.2E+0)	**0** (1.1E-1)
RH-TRU	43,000	48,807	**0** (2.0E-1)	**5** (4.9E+0)	**0** (6.5E-2)	**90** (9.3E+1)	**8** (8.3E+0)	**0** (2.8E-1)
Total	**163,000**	**67,536**	**0** (4.2E-1)	**7**	**0** (4.7E-1)	**130**	**11**	**0** (3.9E-1)

(a) Impacts are based on information in WIPP SEIS-2 (DOE 1997b). The results presented here may not exactly match the WIPP SEIS-2 estimates due to rounding errors.
(b) LCFs = latent cancer fatalities

Number of Shipments

The numbers of shipments in the WIPP SEIS-2 (DOE 1997b) were calculated by dividing the total volume of CH- and RH-TRU wastes by the capacity of the shipping containers used to transport the two types of TRU waste materials. For CH TRU waste, the shipping capacity was about 6.4 m^3 per shipment (three TRUPACT containers carrying fourteen 55-gal-drum equivalents per container). For RH-TRU wastes, the RH-72B shipping cask was used, which carries about 0.9 m^3 per shipment.

Radiological Routine Exposure Risks

The WIPP SEIS-2 did not provide a breakdown of routine exposures by shipping site. However, the per-shipment routine exposures for shipments from Hanford to WIPP were provided. Therefore, the routine radiological impacts presented in Table H.12 were calculated by multiplying together the per-shipment impacts and number of shipments for both CH- and RH-TRU waste shipments.

Radiological Accident Impacts

WIPP SEIS-2 provided a breakdown on radiological-accident impacts by shipping site so the values in Table H.12 were taken directly from that document.

Non-Radiological Impacts

Similar to the radiological routine impacts, WIPP SEIS-2 provided the per-shipment impacts but not a site-by-site breakdown. Consequently, the results in Table H.12 were calculated by combining the per-shipment impacts and the numbers of shipments.

Impacts for HSW-EIS TRU Waste Volumes

The volumes of TRU waste projected to be shipped from Hanford to WIPP in this EIS are substantially lower than the bounding volumes assumed in WIPP SEIS-2. The CH-TRU waste volume projected to be shipped to WIPP in the HSW EIS is about 38,000 m^3 for Alternative Groups A through E. For the No Action Alternative, the projected CH-TRU waste volume to be shipped to WIPP is about 31,000 m^3. This is about one-third of the CH-TRU waste volume projected in WIPP SEIS-2. Similarly, the RH-TRU waste volume projected to be shipped to WIPP in Alternative Groups A through E is about 2800 m^3, or about one-fifteenth of the WIPP SEIS- projections. The ratios of these values were used to adjust the WIPP SEIS-2 impacts for TRU waste shipments from Hanford to the HSW-EIS TRU waste-volume projections. The results are shown in Table H.13.

H.5.2 Transportation Impacts Within Washington and Oregon of Offsite Shipments

This section calculates the impacts of offsite transportation of solid wastes to and from Hanford. Included are the impacts of transporting LLW and MLLW from offsite generators to Hanford Site treatment and disposal facilities and the impacts of transporting MLLW from Hanford to offsite commercial disposal facilities.

Radiological Routine Exposure and Accident Impact Analysis Parameters

The RADTRAN 4 computer code was used to perform the transportation-impact calculations. For offsite shipments, the key differences in RADTRAN parameters are primarily related to the route characteristics (e.g., shipping distances, travel fractions, and population densities in rural, suburban, and urban population zones). For the purposes of this EIS, two routes through Oregon and Washington are

Table H.13. Impacts of Offsite Transportation of TRU Wastes from Hanford to WIPP Adjusted for HSW-EIS Waste Volume[a]

Waste Type	Waste Volume, m^3	Shipments	Radiological Impacts, LCFs			Non-Radiological Impacts		
			Routine Occupational	Routine Non-Occupational	Accidents	Number of Accidents	Fatalities	Vehicle Pollution LCFs
Alternative Groups A, B, C, D, and E								
CH-TRU	40,154[b]	6267	7.5E-2	6.3E-1	1.4E-1	1.2E+1	1.1E+0	3.6E-2
RH-TRU	2815	3195	1.3E-2	3.2E-1	4.3E-3	6.1E+0	5.4E-1	1.9E-2
Total	**42,969**	**9462**	**0** (8.8E-2)	**1** (9.5E-1)	**0** (1.4E-1)	**18** (1.8E+1)	**2** (1.6E+0)	**0** (5.5E-2)
No Action								
CH-TRU	32,714[b]	5106	6.1E-2	5.1E-1	1.1E-1	9.7E+0	8.7E-1	3.0E-2
RH-TRU	0	0	0	0	0	0	0	0
Total	**32,714**	**5106**	**0** (6.1E-2)	**1** (5.1E-1)	**0** (1.1E-1)	**9** (9.7E+0)	**1** (8.7E-1)	**0** (3.0E-2)

LCF = latent cancer fatality
(a) Intermediate values may not add to totals due to rounding.
(b) Includes Hanford Only waste volumes as well as an additional 1500 m^3 of TRU waste to account for small generator sites included in the *Transuranic Waste Performance Management Plan* (DOE 2002b).

assumed to be used exclusively. The first enters Oregon at approximately Ashland, Oregon, on Interstate 5 and travels north to Portland, Oregon. Near Portland, the shipment takes Interstate 205 to Interstate 84 and then travels up the Columbia River Gorge to Umatilla, Oregon. Near Umatilla, the shipments exit Interstate 84 onto Interstate 82, cross into the State of Washington, and travel to Richland, Washington. Near Richland, the shipment exits onto State Route 240 and travels to the Hanford Site. The second route enters the State of Oregon near Ontario, Oregon, on Interstate 84, and travels to Umatilla, Oregon, where it exits onto Interstate 82 and follows the same path to Hanford described for the first route. Note that both routes enter the State of Washington at the Umatilla, Oregon/Patterson, Washington ports of entry.

The HIGHWAY computer code (Johnson et al. 1993) was used to develop this information for the RADTRAN runs. A summary of the route characteristics for transport in Washington and Oregon are shown in Table H.14.

Table H.14. Route Characteristics for Transport in Washington and Oregon

Route Description	Distance, km	Travel Percentage			Population Density, per sq. km		
		Rural	Suburban	Urban	Rural	Suburban	Urban
Enter OR at Ashland	824	75.8%	20.6%	3.6%	10.4	320.2	2242.4
Enter OR at Ontario	430	90.1%	9.1%	0.8	3.9	400.8	1979.6

Table H.15 summarizes the LLW, MLLW, and TRU waste volumes to be transported from offsite generators to Hanford under the Lower Bound and Upper Bound waste-volume cases and the TRU waste volume to be transported from Hanford to WIPP.

Table H.15. Offsite Shipping Volumes Used for Oregon and Washington Impacts Calculations

Shipment Type	Route	Waste Type	Volume, m^3	Number of Shipments
Lower Bound Case				
LLW to Hanford	Ontario, OR	All LLW	23,281	1412
	Ashland, OR	All LLW	1719	105
MLLW to Hanford	Ontario, OR	All MLLW	99	6
	Ashland, OR	All MLLW	1	1
TRU Waste to Hanford	Ontario, OR	CH TRU	1274	161
	Ashland, OR	CH TRU	286	36
TRU Waste to WIPP	Ontario, OR	CH-TRU	40,154	6267
		RH-TRU	2815	3195
		Total TRU	42,969	9462
Upper Bound Case				
LLW to Hanford	Ontario, OR	All LLW	220,707	13,388
	Ashland, OR	All LLW	16,293	992
MLLW to Hanford	Ontario, OR	All MLLW	138,936	8426
	Ashland, OR	All MLLW	1364	1403
TRU Waste to Hanford	Ontario, OR	CH TRU	1274	161
	Ashland, OR	CH TRU	286	36
TRU Waste to WIPP	Ontario, OR	CH-TRU	40,154	6267
		RH-TRU	2815	3195
		Total TRU	42,969	9462

(a) TRU waste volume shipped to Hanford and from Hanford to WIPP includes 1500 m^3 in addition to Upper Bound and Lower Bound waste volumes.

For comparison purposes, the remaining RADTRAN parameters were assumed to be the same as for onsite shipments. This is a realistic assumption because the shipping containers for onsite shipments are required to meet equivalent packaging and transportation standards as shipping containers for onsite shipments. Table H.16 summarizes these routine exposure parameters used in the RADTRAN calculations. Table H.17 summarizes these accident-analysis parameters used in the RADTRAN calculations.

Non-Radiological Impact Analysis Parameters

Impacts from two potential sources of non-radiological impacts are calculated here, including impacts from traffic accidents (fatalities) and routine emissions of vehicular pollutants (latent cancer fatalities). Both types of impacts were calculated by combining unit rates (i.e., fatalities per km traveled), distance per shipment, and the number of shipments. Unit fatality rates for traffic accidents in Washington and Oregon were taken from Saricks and Tompkins (1999). Oregon traffic-fatality-rate data was incomplete

Table H.16. RADTRAN Routine Exposure Parameters Used in Offsite Transportation-Impact Calculations

Parameter	**Value**[(a)]
Transport Index (Dose rate at 1 m from vehicle, mrem/hr)[(b)]	
- LLW and MLLW	3
- CH TRU Waste	7
- RH TRU Waste	7
Number of Truck Crew	2
Average Vehicular Speed (km/hr)	
- Rural	88
- Suburban	40
- Urban	24
Stopped Time (hr/km)	0.011
Number of People Exposed While Stopped	50
Average Exposure Distance at Stops, m	20
Number of People per Vehicle Sharing Route	2
Population Densities (Persons/km^2)	Route-Specific
One-Way Traffic Count (Vehicles/hr)	
- Rural	470
- Suburban	780
- Urban	2800

(a) Source of the parameter values is Neuhauser and Kanipe (1992), except where indicated otherwise.
(b) Source: WM PEIS (DOE 1997a).

in Saricks and Tompkins (1999), so national average fatality rates, which are about four times higher than the average rates in Washington, were used. The unit fatality rate for vehicular emissions was taken from Rao et al. (1982). Both sets of unit-fatality-rate data are commonly used in EISs.

Analysis Results

The transportation impacts in Washington and Oregon for offsite shipments of LLW, MLLW, and TRU waste are presented in Table H.18. The table includes the impacts in Washington and Oregon for both the Lower Bound and Upper Bound waste-volume cases. Table H.19 presents the impacts by state. The estimates in Table H.19 were calculated by scaling the overall results in Table H.18 by the ratio of the mileages in each state to the total mileage traveled in Washington and Oregon. Note that no fatalities are estimated in Washington and Oregon from the offsite shipments. Also note that, although traffic accidents are expected to occur, no fatalities are estimated to result from the traffic accidents.

Table H.17. RADTRAN 4 Accident Parameters for Trucks

<table>
<tr><th colspan="4">Accident Rate
State-Specific Values Used</th></tr>
<tr><th colspan="4">Fractional Occurrence by Severity Category
(Conditional Probability Given an Accident Occurs)[(a)]</th></tr>
<tr><td>Severity Category</td><td colspan="3"></td></tr>
<tr><td>I</td><td colspan="3">0.55</td></tr>
<tr><td>II</td><td colspan="3">0.36</td></tr>
<tr><td>III</td><td colspan="3">0.07</td></tr>
<tr><td>IV</td><td colspan="3">0.016</td></tr>
<tr><td>V</td><td colspan="3">0.0028</td></tr>
<tr><td>VI</td><td colspan="3">0.0011</td></tr>
<tr><td>VII</td><td colspan="3">8.5E-5</td></tr>
<tr><td>VIII</td><td colspan="3">1.5E-5</td></tr>
<tr><th colspan="4">Fractional Occurrence by Population Zone (Conditional Probability Given an Accident Occurs of the Specified Severity)[(a)]</th></tr>
<tr><td></td><th>Rural</th><th>Suburban</th><th>Urban</th></tr>
<tr><td>I</td><td>0.1</td><td>0.1</td><td>0.8</td></tr>
<tr><td>II</td><td>0.1</td><td>0.1</td><td>0.8</td></tr>
<tr><td>III</td><td>0.3</td><td>0.4</td><td>0.3</td></tr>
<tr><td>IV</td><td>0.3</td><td>0.4</td><td>0.3</td></tr>
<tr><td>V</td><td>0.5</td><td>0.3</td><td>0.3</td></tr>
<tr><td>VI</td><td>0.7</td><td>0.2</td><td>0.1</td></tr>
<tr><td>VII</td><td>0.8</td><td>0.1</td><td>0.1</td></tr>
<tr><td>VIII</td><td>0.9</td><td>0.05</td><td>0.05</td></tr>
<tr><th colspan="4">Release Fraction (Fraction of Container Contents Released from Shipment by Severity Category)[(a)]</th></tr>
<tr><td></td><th>Type A (LLW and MLLW)</th><th colspan="2">Type B (CH- and RH-TRU)[(b)]</th></tr>
<tr><td>I</td><td>0</td><td colspan="2">0</td></tr>
<tr><td>II</td><td>0.01</td><td colspan="2">0</td></tr>
<tr><td>III</td><td>0.1</td><td colspan="2">8E-9</td></tr>
<tr><td>IV</td><td>1</td><td colspan="2">2E-7</td></tr>
<tr><td>V</td><td>1</td><td colspan="2">8E-5</td></tr>
<tr><td>VI</td><td>1</td><td colspan="2">2E-4</td></tr>
<tr><td>VII</td><td>1</td><td colspan="2">2E-4</td></tr>
<tr><td>VIII</td><td>1</td><td colspan="2">2E-4</td></tr>
<tr><td colspan="4">(a) Data taken from NUREG-0170 (NRC 1977) for Type A shipments. Release fractions are package-type specific whereas the fractional occurrence parameters are independent of package type.
(b) Data taken from WIPP SEIS-2 (DOE 1997b). Includes contributions from impact and thermal release phenomena.</td></tr>
</table>

Table H.18. Impacts in Washington and Oregon from Shipments of Solid Waste to Hanford from Offsite Generators and Shipments of TRU Waste to WIPP[(a)]

Shipment	Route	Waste Type	Radiological Impacts, LCFs			Non-Radiological Impacts		
			Occupational	Public	Radiological Accident	Number of Accidents	Accident Fatalities	Emissions, LCFs
Lower Bound Case								
LLW to Hanford	Ontario, OR	LLW	5.1E-3	3.6E-3	5.6E-4	1.0E-1	2.2E-3	9.6E-4
	Ashland, OR	LLW	8.8E-4	5.8E-4	3.6E-4	1.5E-2	3.5E-4	6.1E-4
MLLW to Hanford	Ontario, OR	MLLW	1.1E-2	3.4E-3	2.8E-5	1.8E+0	2.0E-2	8.5E-4
	Ashland, OR	MLLW	8.4E-6	5.5E-6	4.2E-5	1.4E-4	3.3E-6	5.9E-6
TRU Waste to Hanford	Ontario, OR	TRU	6.0E-4	4.2E-4	1.1E-5	1.2E-2	2.5E-4	1.1E-4
	Ashland, OR	TRU	1.7E-3	1.1E-3	1.2E-4	3.0E-2	6.7E-4	1.2E-3
Total – All Offsite Generators		All	1.9E-2	9.1E-3	1.1E-3	2.0E+0	2.4E-2	3.7E-3
TRU to WIPP	Ontario, OR	CH-TRU	1.7E-2	1.6E-2	4.4E-4	4.7E-1	1.0E-2	4.3E-3
		RH-TRU	8.6E-3	1.8E-2	2.2E-4	2.4E-1	5.1E-3	2.2E-3
		Total TRU	2.5E-2	3.4E-2	6.6E-4	7.1E-1	1.5E-2	2.7E-2
GRAND TOTAL	**All waste types, to and from Hanford**		**0** (4.5E-2)	**0** (4.3E-2)	**0** (1.8E-3)	**3** (2.7E+0)	**0** (3.9E-2)	**0** (3.1E-2)
Upper Bound Case								
LLW to Hanford	Ontario, OR	LLW	4.8E-2	3.4E-2	5.3E-3	9.9E-1	2.1E-2	9.1E-3
	Ashland, OR	LLW	8.3E-3	5.5E-3	3.4E-3	1.4E-1	3.3E-3	5.8E-3
MLLW to Hanford	Ontario, OR	MLLW	4.1E-2	2.5E-2	4.0E-2	2.4E+0	3.3E-2	6.5E-3
	Ashland, OR	MLLW	1.2E-2	7.8E-3	5.9E-2	2.0E-1	4.6E-3	8.3E-3
TRU Waste to Hanford	Ontario, OR	TRU	6.0E-4	4.2E-4	1.1E-5	1.2E-2	2.5E-4	1.1E-4
	Ashland	TRU	1.7E-3	1.1E-3	1.2E-4	3.0E-2	6.7E-4	1.2E-3
Total – All Offsite Generators		All	1.1E-1	7.4E-2	1.1E-1	3.8E+0	6.3E-2	3.1E-2
TRU Waste to WIPP	Ontario, OR	CH-TRU	1.7E-2	1.6E-2	4.4E-4	4.7E-1	1.0E-2	4.3E-3
		RH-TRU	8.6E-3	1.8E-2	2.2E-4	2.4E-1	5.1E-3	2.2E-3
		Total TRU	2.5E-2	3.4E-2	6.6E-4	7.1E-1	1.5E-2	2.7E-2
GRAND TOTAL	**All waste types, to and from Hanford**		**0** (1.4E-1)	**0** (1.1E-1)	**0** (1.1E-1)	**5** (4.5E+0)	**0** (7.8E-2)	**0** (5.8E-2)

Note: Public includes non-involved workers.

(a) Radiological impacts (incident-free and accident) are expressed in units of LCFs. Non-radiological accident impacts are expressed as the expected number of accidents and the resulting physical trauma fatalities. Non-radiological emissions impacts are expressed as LCFs.

Table H.19. Impacts in Washington and Oregon by State from Offsite Shipments of Solid Wastes to and from Hanford[(a)]

Shipment	State	Radiological Impacts, LCFs			Non-Radiological Impacts		
		Occupational	Non-Occupational	Radiological Accident	Number of Accidents	Accident Fatalities	Emissions, LCFs
Lower Bound Waste Volume							
LLW, MLLW, and TRU to Hanford[(b)]	WA	4.1E-3	1.9E-3	2.2E-4	3.9E-1	5.4E-3	7.9E-4
	OR	1.5E-2	7.2E-3	9.0E-4	1.6E+0	1.8E-2	2.9E-3
TRU Waste to WIPP	WA	4.4E-3	5.9E-3	1.2E-4	1.2E-1	2.6E-3	4.7E-3
	OR	2.1E-2	2.8E-2	5.4E-4	5.9E-1	1.2E-2	2.2E-2
Total - Offsite Shipments	WA	8.6E-3	7.8E-3	3.4E-4	5.2E-1	8.0E-3	5.5E-3
	OR	3.6E-2	3.5E-2	1.4E-3	2.2E+0	3.1E-2	2.5E-2
Grand Total	**WA + OR**	**0** (4.5E-2)	**0** (4.3E-2)	**0** (1.8E-3)	**3** (2.7E+0)	**0** (3.9E-2)	**0** (3.1E-2)
Upper Bound Waste Volume							
LLW, MLLW, and TRU Waste to Hanford[(b)]	WA	2.1E-2	1.4E-2	2.2E-2	7.3E-1	1.3E-2	6.2E-3
	OR	9.0E-2	6.0E-2	8.6E-2	3.1E+0	5.0E-2	2.5E-2
TRU Waste to WIPP	WA	4.4E-3	5.9E-3	1.2E-4	1.2E-1	2.6E-3	4.7E-3
	OR	2.1E-2	2.8E-2	5.4E-4	5.9E-1	1.2E-2	2.2E-2
Total – Offsite Shipments	WA	2.6E-2	2.0E-2	2.2E-2	8.5E-1	1.5E-2	1.1E-2
	OR	1.1E-1	8.8E-2	8.7E-2	3.6E+0	6.3E-2	4.7E-2
Grand Total	**WA + OR**	**0** (1.4E-1)	**0** (1.1E-1)	**0** (1.1E-1)	**5** (4.5E+0)	**0** (7.8E-2)	**0** (5.8E-2)

Note: Public includes non-involved workers.

(a) Radiological impacts (incident-free and accident) are expressed in units of LCFs. Non-radiological accident impacts are expressed as the expected number of accidents and the resulting physical trauma fatalities. Non-radiological emissions impacts are expressed as LCFs.

(b) MLLW shipments include those from offsite generators to Hanford and those to ORR and back for treatment. TRU waste volumes include 1500 m^3 in addition to the Upper Bound and Lower Bound waste-volume projections to account for small-quantity sites identified in the *Transuranic Waste Performance Management Plan* (DOE 2002b).

H.6 Results of Hazardous Chemical Impact Analysis

Downwind concentrations of hazardous chemicals released from a severe transportation accident are presented in this section. The resulting chemical concentrations are put in perspective by comparing them to safe exposure levels. The methods used are standard facility safety-analysis techniques and are proven methods for assessing potential health effects from accidental releases of hazardous chemical materials.

The hazardous chemical constituents of MLLW and TRU waste to be transported to and on the Hanford Site are shown in Table H.6. The downwind concentrations shown in Table H.20 were calculated assuming a maximum-inventory 55-gal drum is involved in a severe accident and releases

0.5 percent of the total inventory of each hazardous chemical as respirable particles into the environment. The downwind concentrations are then compared to Temporary Emergency Exposure Limit-2 (TEEL-2) values given by Craig (2001). The TEEL-2 definition follows.

TEEL-2: The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.

TEEL-2 values are used here instead of the more widely accepted Emergency Response Planning Guidelines (ERPGs), because ERPG values do not exist for some of the chemicals listed in Table H.6. TEEL values are interim replacements for the peer-reviewed ERPG values and may be used when ERPG values are not available. ERPG-2 is analogous to TEEL-2 and is defined as follows:

ERPG-2: The maximum concentration in air below which it is believed that nearly all individuals could be exposed *for up to 1 hour* without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.

The results of the hazardous-chemical-concentration calculations are shown in Table H.20. The results indicate that downwind concentrations of only four hazardous chemicals would exceed the TEEL-2 guidelines following a severe transportation accident involving a maximum-inventory 55-gal drum. These four chemicals are elemental lead, elemental mercury, methyl ethyl ketone (MEK or 2-butanone), and beryllium. For these four chemicals, the Immediately Dangerous to Life and Health (IDLH) values are provided in the table for additional perspective. IDLH concentrations are defined as follows:

IDLH: The maximum concentration from which, in the event of respirator failure, a person could escape within 30 minutes without a respirator and without experiencing any escape-impairing (for example, severe eye irritation) or irreversible health effects.

The IDLH values are driven by worker safety requirements, as indicated by the language on respirator failure.

The downwind concentrations of all four of the IDLH chemicals are well below their respective IDLH values. Based on these observations, the conclusion is that releases of hazardous chemicals from transportation accidents are unlikely to result in a fatality.

The downwind hazardous chemical concentrations are calculated for a person 100 m (109 yd) away from the release point. This assumption is conservative for a member of the public, either offsite or onsite, who is unlikely to be 100 m (109 yd) from the release point for the entire duration of the release. Furthermore, the maximum hazardous-chemical concentrations (referred to as the maximum drum) have been modeled. This model includes, in the case of MLLW, more than 20 hazardous chemicals. It is extremely unlikely that any single 55-gal drum would contain the maximum concentrations of all 20 or more hazardous chemicals. This information provides additional evidence that results shown in Table H.20 are bounding.

Table H.20. Hazardous Chemical Concentrations 100 m (109 yd) Downwind from Severe Transportation Accidents

Hazardous Constituent	Concentration, mg/m^3					
	TEEL-2 Value[(a)]	MLLW[(b)]	TRU Waste[(b)]	Elemental Mercury	Elemental Lead	Comments[(c)]
Acetone	8500	0.49	0	0	0.004	
Ammonium fluoride	12.5	0.19	0	0	0	
Ammonium nitrate	50	0.19	0	0	0	
Ammonium sulfate	500	0.38	0	0	0	
Beryllium	0.025	0.14	0.0049	0	0	IDLH = 10 mg/m^3
Butyl alcohol	50	0.03	0.012	0	0	
Carbon tetrachloride	100	0.89	0.024	0	0	
Cyclohexane	1300	0.09	0	0	0	
Ethanol	3300	0.49	0.0049	0	0	
Hydrazine	0.8	0.21	0	0	0	
Isopropyl alcohol	400	0.71	0	0	0	
Lead	0.25	0	0	0	5.0	IDLH = 700 mg/m^3
Mercury	0.1	0	0	0.67	0	IDLH = 10 mg/m^3
Methanol	1000	0.95	0	0	0	
Methyl ethyl ketone	0.2	0.58	0	0	0	IDLH = 9000 mg/m^3
Methyl isobutyl ketone	500	0.80	0	0	0	
Nitric acid	15	1.48	0.0049	0	0	
Phosphoric acid	500	1.27	0.0073	0	0	
Potassium hydroxide	2	1.37	0	0	0	
Propane	2100	0	0.0097	0	0	
Sodium hydroxide	40	1.86	0.15	0	0	
Styrene	250	0.04	0	0	0	
Sulfuric acid	10	0.08	0.036	0	0	
Tetrahydrofuran	2000	0.07	0	0	0	
Toluene	300	2.53	0	0	0	
Uranium	1	0.009	0	0	0	
Xylene	200	1.26	0.10	0	0	

(a) Source: Craig (2001).
(b) Inventories bound quantities for either CH or RH waste.
(c) IDLH = Immediately Dangerous to Life and Health. Source: National Institute for Occupational Safety and Health (NIOSH 1990).

H.7 Potential Impacts of Sabotage or Terrorist Attack

This section addresses the environmental impacts associated with potential sabotage or terrorist attacks on shipments of solid waste to and from the Hanford Site. The Nuclear Regulatory Commission (NRC) has established regulations designed specifically to protect the public from potential terrorist attacks on certain types of radioactive material shipments (see 10 CFR 71). These requirements are intended to minimize the possibility of sabotage and facilitate recovery of shipments that could come into control of unauthorized persons. The requirements minimize the impacts of malevolent acts during transport of the most dangerous types of radioactive materials, including spent nuclear fuel and special nuclear materials that could be used to construct nuclear weapons. The NRC rules require, for example, advance route approval, advance arrangements with local law-enforcement agencies along the route, advance notification of states, escort requirements, and onboard communications equipment. These rules apply to offsite shipments in the general-public domain when conditions along transport routes cannot be controlled.

None of the solid waste materials covered by this EIS are required to implement special safeguards and security provisions. In general, the solid waste materials have low radioactivity levels relative to spent nuclear fuel and none qualify as special nuclear material that would require special safeguards and security considerations.

In addition to the physical-protection requirements in 10 CFR 73, the shipping containers themselves provide a measure of protection. Type B accident-resistant packaging systems are required for the most hazardous shipments, such as TRU waste and certain high-quantity LLW and MLLW shipments, as well as ILAW containers. These packaging systems, which are designed to withstand severe mechanical and thermal environments, provide a significant amount of protection from terrorist attacks. Lower hazard materials, including most LLW and MLLW shipments, do not require accident-resistant Type B packages. They are shipped in Type A packages. However, the less hazardous shipments are not attractive terrorist targets because they would not involve a high-profile symbol of the United States nor would a successful attack produce a large number of immediate fatalities. The latter observation is based on the results of an assessment of radioactive releases from a spent nuclear fuel shipping cask subjected to an attack using a high-energy device (Luna et al. 2000). The maximum individual dose from such an event involving a spent-nuclear-fuel shipping cask, which carries orders of magnitude greater radioactive material than typical solid waste shipping containers, was well below that which would cause an immediate radiation-induced fatality.

An additional element to consider is that most of the shipments of radioactive waste covered in this EIS are within Hanford Site boundaries. Hanford is a controlled-access facility that is protected by various security measures, for example, security guards and visual surveillance systems. Onsite shipments of solid waste would be protected by these same systems, which lessens the likelihood of a successful terrorism incident.

To provide some perspective on the potential impacts of a terrorist attack on a shipment of radioactive materials addressed in this EIS, the consequences of the most severe accident (i.e., Severity Category VIII), involving a spent nuclear fuel shipment, modeled in the RADTRAN accident analysis, were determined.

The results indicate that such an attack, if conducted successfully in an urban area, could result in a population dose of about 48,000 person-rem. Such a population dose would result in about 24 excess LCFs in the exposed population. If the attack occurred in a rural area, the consequences would be much lower, approximately 160 person-rem, and 0 excess LCFs. These are conservative estimates because they assume that the attack results in complete loss of containment and interdiction, and other measures that would lessen the impacts are not accounted for. Shipments associated with waste evaluated in this HSW EIS would have lower radionuclide inventories and would be expected to have correspondingly smaller consequences.

Because of the terrorist attacks on September 11, 2001, DOE and other agencies are reviewing the physical-protection requirements for shipments of radioactive materials. Any findings and recommendations from this re-examination would be incorporated into DOE's plans for shipping solid waste materials to, from, and within the Hanford Site.

H.8 Comparison with Waste Management Programmatic Environmental Impact Statement

The *Final Waste Management Programmatic Environmental Impact Statement* (WM PEIS, DOE 1997b) evaluated the nationwide impacts of managing four types of radioactive waste (LLW, MLLW, TRU waste, and high-level waste) and hazardous waste. The purpose of the WM PEIS was to provide part of the basis for DOE decisions on programmatic configurations of sites for waste treatment and disposal activities. A Record of Decision (ROD) on management of LLW and MLLW was issued on February 25, 2000 (65 FR 10061). DOE decided, among other things, to continue onsite disposal of LLW at four DOE sites and to make Hanford and the Nevada Test Site (NTS) available to all DOE sites for disposal of LLW and MLLW. The HSW EIS and WM PEIS analyzed similar configurations for treatment and disposal of LLW and MLLW and used similar methods for calculating transportation impacts. The main difference between the purposes of the HSW EIS and the WM PEIS is that the former seeks a site-specific decision on management of LLW, MLLW, and TRU waste, whereas the latter sought decisions on broader, nationwide configurations of sites for management of these and other radioactive wastes.

Given the similarities in scope and analytical methodologies between the HSW EIS and WM PEIS, it could be asked if the impacts calculated in both documents are comparable. A comparison was made between the transportation impacts calculated in the WM PEIS and HSW EIS in an effort to understand what the differences are, if any. The WM PEIS information was taken from the *Information Package on Pending Low-Level Waste and Mixed Low-Level Waste Disposal Decisions to be made under the Final Waste Management Programmatic Environmental Impact Statement* (DOE 1998) that was developed to support the LLW/MLLW Record of Decision.

This exercise led to the following observations. First, the WM PEIS scope was limited to 20 years whereas the HSW EIS covers the lifecycle of the Hanford Site Solid (Radioactive and Hazardous) Waste Management Program (through 2046). Consequently, the LLW and MLLW volume projections are significantly different, leading to differences in the transportation impacts. In addition, the WM PEIS was published in 1997, so the waste-volume projections are several years older than the waste-volume projections used in the HSW EIS. The HSW EIS volumes from offsite generators have been verified with the generator sites and are thought to be more realistic than waste volumes analyzed in the WM PEIS. Finally, some of the data was used in the transportation-impact calculations, for example, transportation-accident statistics, have been updated from previous studies. This has led to small differences in impacts relative to the differences that arise from the waste-volume projections.

H.9 Effects of Transporting Solid Waste by Rail

The analyses in this appendix assumed that all of the onsite and offsite shipments of solid waste would be conducted using trucks over existing roads. It is possible that some of the shipments of solid waste and construction/capping materials could be transported by rail. Rail shipments generally result in lower impacts than truck shipments. These lower impacts for rail relative to truck shipping are documented in numerous EISs (DOE 2002a, 1997a, 1997b). Generally, rail shipments result in lower impacts than truck shipments for a variety of reasons:

- Rail payload capacity is substantially greater than truck. This results in fewer shipments which, in turn, results in lower transportation impacts.

- There are fewer people sharing a rail line than would be sharing the highway with truck shipments. This is somewhat offset by the lower average speeds for rail shipments, which increases the exposure time relative to truck shipments.

- When a rail shipment stops at a railyard, there are many other railcars that provide shielding between the shipping container and any people. This shielding results in lower radiation dose rates, and thus lower radiation exposures, to bystanders and people living in the vicinity of rail stops relative to truck stops.

- According to recent data in Saricks and Tompkins (1999), fatality rates for truck and rail transport are comparable. For example, the nationwide accident and fatality rates for truck shipments are about 3.2E-7 accidents per truck-km and 1.4E-8 fatalities per truck-km, respectively (see Table 4 of Saricks and Tompkins [1999]). For rail shipments, the comparable nationwide accident rate is about 5.4E-8 accidents per railcar-km and the fatality rate is about 2.1E-8 fatalities per railcar-km (see Table 6 of Saricks and Tompkins [1999]). Although the fatality rate on a per-km basis is higher for rail than for truck shipments, the rail shipments travel fewer miles than truck shipments due to the higher payload capacity of the rail shipments. The higher payloads for rail shipments more than offset the difference in fatality rates, resulting in lower non-radiological accident impacts for rail shipments.

While rail shipments generally result in lower radiological incident-free and non-radiological accident impacts than truck shipments, the impacts of radiological accidents are likely to be higher for rail shipments than truck shipments. Recall that radiological accident impacts are calculated as the product of the frequency of an accident times its consequences. While the probability of a severe accident is comparable between the two modes as discussed above, the consequences of a severe rail accident would be greater due to the higher payload of rail shipments relative to truck shipments; i.e., larger quantities of radioactive materials would be released from a rail shipment than a truck shipment. This leads to generally higher radiological accident impacts for rail shipments relative to truck shipments. However, a review of the impact estimates in Table H.10 indicates that radiological accident impacts are a small fraction of the radiological incident-free and non-radiological impacts. Therefore, the radiological accident impacts do not contribute substantially to the total impacts.

Although predicted impacts for rail shipments would likely be smaller than for truck shipments, a number of other variables must also be considered. First, general freight rail service is slower than truck shipping, resulting in longer travel times and possibly long stop times in rail yards waiting for train makeup. The longer shipping times for rail shipments may also lead to less efficient use of DOE shipping containers, depending on the waste types transported by rail and the truck/rail mix of the shipping campaigns. Second, not all generator sites, including Hanford, are provided with rail service. In order for these sites to use rail service, they would have to construct new rail lines, rebuild existing lines that have been discontinued, or implement truck/rail intermodal transportation (i.e., deliver truck shipments to a railyard where the shipping containers would be offloaded from the trucks and loaded onto a rail car for subsequent transport; the opposite operation would be required if the receiving site is also not provided with rail service). This could lead to increased costs as well as increased impacts due to the additional handling activities required to offload and reload the containers onto or off of the railcars. Third, if a rail accident involving a derailment were to occur, the rail line could be disabled for a lengthy period of time. Although truck accidents could also involve closure of a highway, there is a greater potential for a detour around a closed highway than around a closed rail line.

There are two types of rail service available for radioactive waste shipments; 1) general freight rail in which the railcars carrying the wastes would be added to an existing train and 2) dedicated rail service in which a train would be made up solely of railcars carrying radioactive wastes to/from Hanford plus locomotives and buffer cars as needed. According to DOE (2002), dedicated rail service offers advantages over general freight rail service in incident-free transport but could lead to higher accident impacts. It was concluded in DOE (2002) that available information does not indicate a clear advantage for the use of either general freight or dedicated train service.

A final point relative to rail shipping is that the HSW management facilities are not currently provided with rail service. Although restarting rail service to the Waste Treatment Plant is currently under consideration, new rail spurs and upgrades to existing rail lines would be needed to reach the HSW treatment facilities. At this time, it is too speculative to assume that rail access to solid waste management facilities on the Hanford Site would be available, and an analysis of rail transport does not appear warranted.

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